An Officer and a Scholar: Nineteenth-Century West Point and the Invention of the Blackboard

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Over two centuries after the invention of blackboards, they still feature prominently in many American classrooms. The blackboard has outlasted most other educational innovations and technologies, and has always been more than an *aide memoire*. Students and teachers have long assumed inscriptions on its surface made mental processes visible. As early as 1880, in fact, the A.H. Andrews & Co. catalog described the blackboard as a "mirror reflecting the workings, character, and quality of the individual mind."[1] The blackboard's ultimate origins are unclear but in North America one institution, the United States Military Academy at West Point, New York, played a particularly important

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[1] A.H. Andrews & Co., *Illustrated Catalogue of School Merchandise* (Chicago, IL: A.H. Andrews & Co.,1881), 73, quoted in David Tyack and Larry Cuban, *Tinkering Toward Utopia: A Century of Public School Reform* (Cambridge, MA: Harvard University Press, 1995), 121. On ubiquitous but "invisible" educational technologies, see Martin Lawn and Ian Grosvenor, "Introduction: The Materiality of Schooling," in *Materialities of Schooling: Design, Technology, Objects, Routines*, eds. Martin Lawn and Ian Grosvenor (Oxford, UK: Symposium Books, 2005), 7–17. There is some ethnographic work on the significance of blackboard inscriptions, for example, Michael J. Barany and Donald MacKenzie, "Chalk: Materials and Concepts in Mathematics Research," in *Representation in Scientific Practice Revisited*, eds. Catelijne Coopmans, Michael Lynch, Janet Vertesi, and Steve Woolgar (Cambridge, MA: MIT Press, 2014); there has been more work on the pedagogical significance of inscriptions in science studies generally, for example, Eric Livingston, *The Ethnomethodological Foundations of Mathematics* (London: Routledge, 1986); Bruno Latour, "Drawing Things Together," in *Representation in Scientific Practice*, eds. Michael Lynch and Steve Woolgar (Cambridge, MA: MIT Press, 1990), 19–68; Ursula Klein, *Experiments, Models, Paper Tools: Cultures of Organic Chemistry in the Nineteenth Century* (Stanford, CA: Stanford University Press, 2003); David Kaiser, *Drawing Theories Apart: The Dispersion of Feynman Diagrams in Postwar Physics* (Chicago, IL: University of Chicago Press, 2005).

role in establishing the device within classrooms. The blackboard's use at West Point in the first years of the nineteenth century garnered the novel tool notice and by the Civil War, the blackboard's place had been so firmly established in American schools as to be easily overlooked in importance; it was simply part of the physical and intellectual architecture of the classroom. Subsequent changes in construction and production have affected cost and appearance, but the basic idea of a vertical surface on which erasable inscriptions are made has remained.[2]

Unlike later uses of the blackboard, the device's West Point origins were not located in the need to display images to large groups of students or in the desire for a surface that would temporarily and conveniently hold markings.[3] Rather, this article will argue that the blackboard was developed in conjunction with a specific examination culture, one designed to cultivate students capable of excelling at oral recitations conducted at the board. The evidence will also suggest that there is nothing predetermined about the politics of educational technologies. Objects like the blackboard do not come equipped with their own interpretations—there is nothing natural or inevitable about its accompanying practices or meanings. What has become a flexible instrument, at home in both university math departments and kindergarten classes, was initially promoted as a specific disciplinary tool of military education.

The period of the blackboard's introduction at West Point—the first decades of the nineteenth century—make its study particularly resonant for historians of education. Not only were "common schools" spreading contemporaneously, but the number of degree-granting colleges more than doubled in the first twenty years of the century, causing John Thelin to call higher education in this era America's "cottage

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[2] Peggy Aldrich Kidwell, "An Erasable Surface as Instrument and Product: The Blackboard Enters the American Classroom—1800–1915," *Rittenhouse* 17, no. 2 (December 2003): 85–98. Most historians have surmised that the origins of the blackboard were French and most early adopters in the United States had indeed been trained in or recently taught in France, for example, Florian Cajori, *The Teaching and History of Mathematics in the United States* (Washington, DC: Government Printing Office, 1890), 117, citing Barnard's *American Journal of Education* 16 (1866): 141–42. Tracing the history of the blackboard further into eighteenth-century France is a daunting task, given that the word *tableau* was widely used, and that there appear to be few systematic distinctions made between different means of displaying information on vertical surfaces. By the early nineteenth century, blackboards were clearly a standard part of French education, for example, by the 1830s Charles Sumner witnessed lectures in Paris given by Lefébure de Fourcy and Jean Baptiste Biot in which "the chalk and sponge" were routinely deployed: Edward L. Pierce, ed., *Memoir and Letters of Charles Sumner*, vol. 1: 1811–1838 (Boston, MA: Roberts Brothers, 1893), 256–57.

[3] See Peggy Kidwell's assessment that "blackboards were introduced in the U.S. as a way of teaching mathematical topics to relatively large numbers of students simultaneously," in "An Erasable Surface as Instrument and Product," 86.

industry."[4] Moreover, as Carl Kaestle argued decades ago, this was a period in which the meaning of moral discipline was in transformation, increasingly associated with formal schooling and with methods of "internalized discipline through proper motivation." As public educational institutions proliferated, and as the student population diversified, schools became a central "pillar of the republic." It was, in short, a period in which the maintenance of "law through moral education was part of the republican experiment." As Kaestle concluded, "Moral education thus overlapped citizenship." The technological development of the blackboard at West Point forms a crucial link between these transformations.[5] The blackboard's origin in a specific examination regime emphasizes the way contemporaries integrated concepts of mental discipline into ideas about moral and physical deportment, and its rapid spread to primary schools emphasizes the sometimes-porous boundaries between colleges, military academies, and common schools. Americans recognized that the blackboard provided a new way of disciplining students' minds and bodies. Through a focus on the material history and practices surrounding the blackboard itself—the way the device both inculcated discipline and made it visible—this article grounds the development of a novel technology in specific ideologies and institutions of nineteenth-century moral education.[6]

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[4]John R. Thelin, *A History of American Higher Education* (Baltimore, MD: Johns Hopkins University Press, 2004), ch. 2, esp. 41.

[5]Carl F. Kaestle, *Pillars of the Republic: Common Schools and American Society, 1780–1860* (New York: Hill and Wang, 1983), 67, 97. For more recent scholarship on how early nineteenth century educational institutions were framed in republican and national terms, see Rita Koganzon, "'Producing a Reconciliation of Disinterestedness and Commerce': The Political Rhetoric of Education in the Early Republic," *History of Education Quarterly* 52, no. 3 (August 2012): 403–29 and Margaret A. Nash, "Contested Identities: Nationalism, Regionalism, and Patriotism in Early American Textbooks," *History of Education Quarterly* 49, no. 4 (November 2009): 417–41; For early studies of the changing nature of higher education in this period—and its relationship with changing notions of discipline—see David F. Allmendinger Jr., "New England Students and the Revolution in Higher Education, 1800–1900," *History of Education Quarterly* 11, no. 4 (Winter 1971): 381–89 and David B. Potts, "American Colleges in the Nineteenth Century: From Localism to Denominationalism," *History of Education Quarterly* 11, no. 4 (Winter 1971): 363–80. More broadly on the history of schools as mechanisms for virtue, see David Tyack and Elisabeth Hansot, *Managers of Virtue: Public School Leadership in America, 1820–1980* (New York: Basic Books, 1982). Although of less significance to the present essay, the examination itself might be considered another influential technological development of this period, for example, John Carson, *The Measure of Merit: Talents, Intelligence, and Inequality in the French and American Republics, 1750–1940* (Princeton, NJ: Princeton University Press, 2007) and Andrew Warwick, *Masters of Theory: Cambridge and the Rise of Mathematical Physics* (Chicago, IL: University of Chicago Press, 2003).

[6]Stephen Petrina has argued for the importance of grounding the history of educational technologies in the contingent premises and principles of contemporary schools. His essay also provides a critical introduction to the existing literature on the history of educational technologies: Stephen Petrina, "Getting a Purchase on 'The School of

Historians have yet to fully acknowledge this role of the blackboard in nineteenth-century education. Although historians of higher education have highlighted the importance of "right conduct" for universities since Frederick Rudolph's work in the 1960s, the material technologies by which morality, discipline, and classroom order were inculcated in nineteenth-century American colleges have not been equally well examined.[7] Even historical studies of the blackboard simply mention West Point as an early adopter of the device, and do not explore its importance for the Academy's entire method of instruction or its role in establishing new forms of mental discipline.[8] Similarly, modern historians of West Point, while often mentioning the blackboard's early use there, have not emphasized the significance of the material practices at and on the

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Tomorrow' and Its Constituent Commodities: Histories and Historiographies of Technologies," *History of Education Quarterly* 42, no. 1 (March 2002): 75–111.

[7] Synthetic histories of antebellum higher education have not traditionally focused on the materiality of the early university classroom, for example, Frederick Rudolph, *The American College and University: A History* (New York: Vintage Books, 1962); Laurence R. Veysey, *The Emergence of the American University* (Chicago, IL: University of Chicago Press, 1965); Julie A. Reuben, *The Making of the Modern University: Intellectual Transformation and the Marginalization of Morality* (Chicago, IL: University of Chicago Press, 1996); Roger Geiger, ed., *The American College in the Nineteenth Century* (Nashville, TN: Vanderbilt University Press, 2000); and Thelin, *A History of American Higher Education*. There has been more historical work done on the materiality of technical textbooks and laboratories. For higher education, see, for example, Bernadette Bensaude-Vincent, "Textbooks on the Map of Science Studies," *Science & Education* 15 (2006): 667–70 and Marga Vicedo, ed., "Focus: Textbooks in the Sciences," *Isis* 103 (2012); and for primary education, for example, John Rudolph, "Teaching Materials and the Fate of Dynamic Biology in American Classrooms after Sputnik," *Technology and Culture* 53, no. 1 (January 2012): 1–36; Nash, "Contested Identities"; Karen D. Michalowicz and Arthur C. Howard, "Pedagogy in Text: An Analysis of Mathematics Texts from the Nineteenth Century," in *A History of School Mathematics*, eds. George M.A. Stanic and Jeremy Kilpatrick (Reston, VA: National Council of Teachers of Mathematics, 2003) 1, 77–109; and Richard L. Venezky, "A History of the American Reading Textbook," *The Elementary School Journal* 87, no. 3 (January 1987): 246–65. In general, the role of material objects—and the charisma or authority that inhered in them—has been better studied for early modern European universities, for example, William Clark, *Academic Charisma and the Origins of the Research University* (Chicago, IL: University of Chicago Press, 2006).

[8] Recent historical work has begun to trace in detail the nineteenth-century history of the blackboard, but as noted earlier, historians often mistakenly assume the blackboard was introduced primarily to teach large groups. See Kidwell, "An Erasable Surface as Instrument and Product" and the related chapter, Peggy Aldrich Kidwell, Amy Ackerberg-Hastings, and David Lindsay Roberts, "The Blackboard: An Indispensable Necessity," in *Tools of American Mathematics Teaching, 1800–2000* (Washington, DC, and Baltimore, MD: Smithsonian Institution and The Johns Hopkins University Press, 2008), 21–34; Caitlin Donahue Wylie, "Teaching Manuals and the Blackboard: Accessing Historical Classroom Practices," *History of Education* 41, no. 2 (March 2012): 257–72; Caitlin Donahue Wylie, "Teaching Nature Study on the Blackboard in Late Nineteenth- and Early Twentieth-Century England," *Archives of Natural History* 39, no. 1 (2012): 59–76; and for an early study, Charnel Anderson, "Technology in American Education 1650–1900," *U.S. Department of Health, Education and Welfare Bulletin*, no. 19 (1962).

board as constitutive of the mechanisms of nineteenth-century recitations.[9] Nineteenth-century historians of the Academy paid far more attention to the blackboard's role, however, recognizing its importance for the establishment of the Academy's pedagogical methods.[10] Likewise, reports of the "Board of Visitors"—an unusual governance element through which a selected group of distinguished academics and military officers produced yearly assessments of the Academy—often emphasized the significance of the blackboard.[11]

Some of this gap in modern scholarship may simply be a consequence of the complications histories of educational technologies present. Material history demands that historians simultaneously engage both the physical concreteness of artifacts as well as the myriad interpretations and meanings individuals ascribed to them. The task is easier in this particular case because blackboards, in Lorraine Daston's terminology, are "things that talk."[12] They revealed cadets' mettle and knowledge to nineteenth-century West Point instructors, and they clarify for historians how technology was integrated with changing notions of mental discipline and moral education.

The blackboard's place in West Point's curriculum is more than an isolated case study. West Point was one of the premier antebellum science and engineering schools, producing generations of technically skilled graduates who populated the growing ranks of military and

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[9]For examples of West Point historians' typically brief mention of the blackboard, see Sidney Forman, *West Point: A History of the United States Military Academy* (New York: Columbia University Press, 1950), 79; Stephen E. Ambrose, *Duty, Honor, Country: A History of West Point* (Baltimore, MD: The Johns Hopkins University Press, 1966), 97–98 (where Ambrose, incorrectly, implies that the blackboard's use ceased after a pertinent textbook was written); James L. Morrison Jr., *"The Best School in the World": West Point, the Pre-Civil War Years, 1833–1866* (Kent, OH: Kent State University Press, 1986), 87; George S. Pappas, *To The Point: The United States Military Academy, 1802–1902* (Westport, CT: Praeger, 1993), 32. Peter Michael Molloy, "Technical Education and the Young Republic: West Point as America's École Polytechnique, 1802–1833" (Ph.D. diss., Brown University, 1975) is a slight exception in that he mentioned the blackboard repeatedly, but he is mainly focused on tracing the blackboard and recitation back to France than in exploring its productive role for West Point over the course of the nineteenth century (pp. 124, 391).

[10]Samuel E. Tillman, "The Academic History of the Military Academy, 1802–1902," in *The Centennial of the United States Military Academy at West Point, New York: 1802–1902, Vol 1: Addresses and Histories* (Washington, DC: Government Printing Office, 1904), 223–438; and E. D. Mansfield, "The United States Military Academy at West Point," *American Journal of Education* 30 (March 1863): 17–40.

[11]Some of the nineteenth-century reports of the Board of Visitors are posted on the online-resource page of West Point (http://www.library.usma.edu) and others are in bound journals at the United States Military Academy Archives, West Point, New York, or in the National Archives. Hereafter, they will just be noted by year, with page number as available.

[12]Lorraine Daston, ed., *Things That Talk: Object Lessons from Art and Science* (New York: Zone Books, 2004), esp. 9–26.

civilian engineers.[13] With the seed for a military academy planted in the early years of the century and nourished by the American experience of the War of 1812, West Point was meant to be an American version of the recently developed French engineering and officer training schools. The Academy's approach merged the tactical training of officers with the scientific training of engineers, creating a pedagogical methodology designed to identify and cultivate men with the intellectual and moral fortitude to lead soldiers into battle. The blackboard would help forge both officers and scholars.[14]

This article will trace the blackboard's history at West Point by moving out from the device's initial role in the curriculum to its eventual place in the Academy's overall disciplinary program. Then, the argument will shift to the broader significance of that program for what Michel Foucault called a "disciplinary society" and analyze the blackboard's role in West Point faculty's attempts to establish an educational model suited to the challenges facing a young republic in the early nineteenth century. An account of the blackboard's establishment should, however, begin with its role in the West Point mathematics classroom. In particular, West Point's course in descriptive geometry, introduced in the 1810s, first demonstrated how the blackboard fostered students' ability to think and, simultaneously, to act well—that is, how the blackboard cultivated future officers' heads and hands.

Head and Hand: Crozet and Mathematics at the Blackboard

Although an instructor named George Baron apparently used the blackboard in the Academy's first years, it was in the context of Claudius Crozet's descriptive geometry courses that the blackboard was first systematically deployed within an overall pedagogical program.[15] In a period where almost no Americans conducted original mathematical research, outside of Harvard's Benjamin Peirce, West Point was the first institution to emphasize higher mathematics as part of the standard program for students. Its graduates would go on to teach in many colleges, as well as serve distinguished careers within the mathematical

[13] For the breadth of West Point's contributions to nineteenth-century science, see Chris Arney, *West Point's Scientific 200: Celebration of the Bicentennial* (Lexington, SC: Palmetto Bookworks, 2002); See also Stanley M. Guralnick, *Science and the Ante-Bellum American College* (Philadelphia, PA: American Philosophical Society, 1975) and George H. Daniels, *American Science in the Age of Jackson* (New York: Columbia University Press, 1968).

[14] Robert M.S. McDonald, ed., *Thomas Jefferson's Military Academy: Founding West Point* (Charlottesville, VA: University of Virginia Press, 2004); Molloy, "Technical Education and the Young Republic."

[15] Tillman, "The Academic History of the Military Academy," 244; Mansfield, "The United States Military Academy," 32–33.

sciences of surveying, navigation, and drafting. West Point's scientific and mathematical textbooks were widely used throughout the country and the Academy was an early innovator in establishing collegiate mathematical education.[16]

Crozet remained at the Academy for only seven years after his 1816 arrival but those were crucial ones for the institution and particularly for the creation of its mathematics program. Formally established in 1802 (a previous school had existed on the site), the first decade of the Academy was halting at best, with no fixed curriculum or academic requirements. Students were declared "graduated" when they were selected for a military appointment, however many courses they had completed. The replacement of Alden Partridge by Sylvanus Thayer as superintendent in 1817, particularly following upon the War of 1812 and the apparent revelation that there was an acute need for well-trained engineers and officers, created an opportunity for the institution to be established on firm footing. Over the next decade, Crozet and his fellow West Point instructors defined a curriculum and examination structure that put mathematics and the blackboard at its core. This model of instruction remained remarkably stable over the course of the century. Nearly every nineteenth-century faculty member was himself educated at West Point, and two professors, Albert Church and Dennis Hart Mahan, taught there from the 1820s to the 1870s. (Another graduate, Charles Davies, taught mathematics from 1815 until 1837, and his textbooks continued to be used long after his departure.) Commentators as late as the 1860s noted that the curriculum had been "crystallized" during the reign of Thayer and Crozet, and had hardly changed since.[17]

A tall and imposing figure with deep-set eyes, quick speech, and strongly accented English, Crozet made an impression upon his arrival that was clearly remembered by former students decades later. American contemporaries considered Crozet to be extremely well qualified, with one visitor to the Academy assessing him—perhaps a bit over-enthusiastically—as "by far the best Mathematician in the United States."[18] Crozet had trained at France's École Polytechnique from 1805 to 1807, a time when, under Napoleon's influence, the engineer-

[16]Karen Hungar Parshall and David E. Rowe, *The Emergence of the American Mathematical Research Community, 1876–1900: J.J. Sylvester, Felix Klein, and E.H. Moore* (Providence, RI: American Mathematical Society, 1994), 17–21; Cajori, *Teaching and History of Mathematics*, ch. 1, esp. 121; Tillman, "The Academic History of the Military Academy," 244–45.

[17]Mansfield, "United States Military Academy," 17–18, 20, 30–31; Molloy, "Technical Education and the Young Republic," 411–12.

[18]John H. B. Latrobe, *Reminiscences of West Point from September, 1818, to March, 1882* (East Saginaw, MI: Evening News, 1882), 30; for the quotation, Board of Visitors Report, 1822.

ing school had been increasingly organized along militaristic lines. He subsequently gained renown as a master engineer in Napoleon's expeditions throughout Europe. After the restoration of Louis XVIII, Crozet—ever loyal to Napoleon and appalled by the poor treatment of those sympathetic to the deposed regime—resigned from service and sailed to the United States. Crozet heard of a faculty position at West Point, applied, and, although not the first choice, received an offer solely on the basis of his reputation.[19]

Many early nineteenth-century colleges followed French models, but West Point's faculty especially praised France's technical and military expertise, and related educational institutions. As Peter Molloy has shown in great detail, West Point was explicitly a hybrid between the École Polytechnique and the École Spécial Militaire, France's schools for engineering and officer training. French was required as a first-year course at West Point in order to ensure students could read untranslated textbooks in subsequent years. Similarly, when the Academy needed to expand the library in the 1810s, the Department of War sponsored an expedition to France so professors could purchase hundreds of pedagogical and scientific books. Many of the professors in the first decades of the institution were themselves French, often having trained at the École Polytechnique, and most of the rest (including two Academy superintendents, Thayer and Jonathan Williams) had visited France.[20] Well into the century, members of the Academy's faculty were openly sympathetic for the French loss at Waterloo, and when instructors formed a new intellectual society in the 1840s, they called it the "Napoleon Club" and used its meetings to debate the virtues of various military strategies adopted in the Napoleonic campaigns.[21]

Crozet's introduction of the blackboard positioned the device within a specifically French tradition of mathematics education. Initially

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[19]Robert F. Hunter and Edwin L. Dooley, Jr., *Claudius Crozet: French Engineer in America 1790–1864* (Charlottesville, VA: University Press of Virginia, 1989), 1–18; Margaret Bradley, "Scientific Education versus Military Training: The Influence of Napoleon Bonaparte on the Ecole Polytechnique," *Annals of Science* 32 (1975): 415–49, esp. 418.

[20]Molloy, "Technical Education and the Young Republic," esp. 34–37, 57–58, 131; Rudolph, *American College and University*, 37–39; Tillman, "Academic History," 276 [based on research of Gustave G. Fieberger]; Mansfield, "The United States Military Academy at West Point," 26–28; Jennings L. Wagoner and Christine Coalwell McDonald, "Mr. Jefferson's Academy: An Educational Interpretation," in *Thomas Jefferson's Military Academy*, 118–53, esp. 139; Hunter and Dooley, *Claudius Crozet*, 15–17; R. Ernest Dupuy, *Where They Have Trod: The West Point Tradition in American Life* (New York: Frederick A. Stokes Company, 1940), 201.

[21]Dupuy, *Where They Have Trod*, 84; Ambrose, *Duty, Honor, Country*, 138–39; Thomas Everett Griess, "Dennis Hart Mahan: The West Point Professor and Advocate of Military Professionalism, 1830–1871" (Ph.D. diss., Duke University, 1969), 236.

assigned to teach engineering, Crozet insisted on teaching descriptive geometry as a crucial component of military education, mirroring the subject's importance at the École Polytechnique. That institution's most influential early leader, Gaspard Monge, believed that the emergent technocracy in republican France ought to be focused on the exact sciences and ensured that a *polytechnicien's* knowledge and actions were based in the study of mathematics. He devoted nearly half the space in the school's prospectus to descriptive geometry alone.[22] The first year Crozet spent at the elite French school was, significantly, one in which Monge was not called away for political duties. Like many fellow *polytechniciens*, Crozet was so impressed with Monge after this year that he would become a lifelong proselytizer for his teacher's pedagogical and scientific views.[23]

For Monge, descriptive geometry represented a unification of the practical arts and the abstract sciences. This grounding of concrete reasoning in sensory experience was pervasive in French educational philosophy around 1800, from the preparatory (and short-lived) écoles centrales to the École Polytechnique and the further specialist training provided by artillery and engineering schools. Monge explicitly linked descriptive geometry to the importance of an underlying foundation in "sensualist" philosophical premises and concrete constructions. Rather than solving equations algebraically to find points of intersection, for example, descriptive geometry required that students draw a series of planes cutting the surfaces and then find the points common to both surfaces in order to construct any curves of intersection. A technique of this sort is essentially visual: it was a mathematical discipline of visualization more so than of measurement or computation.[24] That is, a subject perfectly suited to work on a blackboard.

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[22] Ivor Grattan-Guinness, *Convolutions in French Mathematics, 1800–1840*, 3 vols (Basel: Birkhäuser Verlag, 1990), 1:95; Bruno Belhoste, "The École Polytechnique and Mathematics in Nineteenth-Century France," in *Changing Images in Mathematics: From the French Revolution to the New Millennium*, eds. Umberto Bottazzini and Amy Dahan Dalmedico (London: Routledge, 2001), 15–30; Bruno Belhoste, *La Formation d'une Technocratie: L'école Polytechnique et ses Élèves de la Révolution au Second Empire* (Paris: Belin, 2003); Charles Coulston Gillispie, *Science and Polity in France: The Revolutionary and Napoleonic Years* (Princeton, NJ: Princeton University Press, 2004), 525. Monge's influence was still palpable at the centenary celebrations: Comité du Centenaire, École Polytechnique, *Livre du Centenaire 1794–1894* (Paris: Gauthier-Villars et Fils, 1895), 45.

[23] Hunter and Dooley, *Claudius Crozet*, 4; René Taton, *L'œvre Scientifique de Monge* (Paris: Presses Universitaires de France, 1951), 100.

[24] Frederick B. Artz, *The Development of Technical Education in France 1500–1850* (Cambridge, MA: MIT Press, 1966), 126–70; Joan L. Richards, "Rigor and Clarity: Foundations of Mathematics in France and England, 1800–1840," *Science in Context* 4, no. 2 (Autumn 1991): 297–319; Joan L. Richards, "Historical Mathematics in the French Eighteenth Century," *Isis* 97, no. 4 (December 2006): 700–713; Lorraine J. Daston, "The

For *polytechniciens* trained under Monge, descriptive geometry was as much a political intervention as a technical practice. While he readily acknowledged that the mathematics of descriptive geometry had been known for centuries, Monge's aim was to bring together the disparate techniques used by architects, cartographers, carpenters, and locksmiths into one unified theory of "la géométrie moderne."[25] Unlike the abstruse analytical mathematics used in celestial mechanics, optics, heat, and electricity, Monge emphasized the relevance of descriptive geometry for practical mechanics, military technology, and engineering, a scheme closely tied to the broader desire to foster popular—republican—education.[26] Following the Marquis de Condorcet's promotion of "social mathematics," Monge envisioned that the curriculum of the École Polytechnique would prepare students for "public service" and careers with "social utility," based on the presumption that political and social problems were best approached through knowledge of mathematics, particularly geometry.[27] Monge's version of descriptive geometry was simultaneously good for mind and body: a foundational subject based in true principles that was also a demonstration of the relevance of mathematical theory for solving a wide range of practical problems.

Crozet brought to West Point Monge's vision of descriptive geometry as a unification of the practical and abstract, and as the appropriate course of study for an institution charged with cultivating the elite of a new republic. With Thayer—the superintendent having himself observed mathematics courses during a visit to the École Polytechnique—Crozet set descriptive geometry as a crucial component of the curriculum. The subject was assigned to be a second-year course in the middle of a cadet's academic program, literally bridging elementary mathematics and the study of tactics and engineering. Recognizing Crozet's accomplishments and reaffirming the topic's importance, the Department of War asked him to undertake an English-language textbook in descriptive geometry designed for cadets, a project finished in 1821. Crozet's text followed the arrangement of Monge's descriptive geometry textbook, itself based on courses given at the École

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Physicalist Tradition in Early Nineteenth Century French Geometry," *Studies in History and Philosophy of Science* 17, no. 3 (1986): 269–95, on 281–82.

[25] Taton, *L'œvre Scientifique de Monge*, 50–51, 84; Daston, "Physicalist Tradition," 280.

[26] Daston, "Physicalist Tradition," 290–91.

[27] Bruno Belhoste, "Un Modèle à l'Épreuve: L'École Polytechnique de 1794 au Second Empire," in *La Formation Polytechnicienne 1794–1994*, eds. B. Belhoste, A. Dahan Dalmedico, and A. Picon (Paris: Dunod, 1994), 9–30, on 12–17; Keith Michael Baker, *Condorcet: From Natural Philosophy to Social Mathematics* (Chicago, IL: University of Chicago Press, 1975).

Polytechnique. External visitors also praised the introduction of Polytechnique-inspired mathematics into the curriculum of the young Academy. In 1823, General George Izard allowed that even if instruction in other subjects failed completely and the "advantage derived from the Academy limited to this single Department of Science[,] I should consider it as an ample compensation to the Country for the expense of its establishment." With such support, Thayer decided that a cadet's day should begin and end with mathematics, an emphasis retained for much of the century.[28]

As at the École Polytechnique, West Point's courses in descriptive geometry promoted a specific link between head work and hand work—between mastery of mind and body—which the Academy's faculty believed was particularly important for officers commanding soldiers in the field. The faculty reported in 1843 that the curriculum's goal was to submit each cadet to a "thorough course of mental as well as military discipline, to teach him to reason accurately, and readily to apply right principles to cases of daily occurrence in the life of a soldier." Nothing was more suited to this than "a strict course of mathematical and philosophical study, with applications to the various branches of military science."[29] The role of descriptive geometry was indicative of what historians of military science have emphasized as the distinctive way West Point's instructors intermingled the study of civil engineering, military fortifications, and officer training. Geometry was not just a collection of ancient facts but a practical skill on the battlefield, where instructors expected soldiers to be able to quickly analyze lines of maneuver and the geography of a terrain.[30] While just one of the subjects taught, the curriculum heavily emphasized mathematics, and especially descriptive geometry, because it furnished precisely the right training for officers.

Descriptive geometry required close attention to the physicality underlying the construction of lines and the motion of points, making it extremely well suited to work at the blackboard. Monge's courses in

[28]See schedule of daily activities pasted in endpapers of *General Regulations for the Army; or, Military Institutes* (Philadelphia, PA: M. Carey and Sons, 1821); Board of Visitors Report, 1820; C. Crozet, *A Treatise on Descriptive Geometry, For the Use of the Cadets of the United States Military Academy, Part 1* (New York: A.T. Goodrich and Co., 1821), following G. Monge, *Géométrie Descriptive*, new ed. (Paris: Klostermann, 1811). Crozet's plans for a second volume never came to fruition. For Thayer's experience in France: Molloy, "Technical Education and the Young Republic," 374. For Izard: Board of Visitors Report, 1823, 91.

[29]Quoted in Tillman, "Academic History," 245.

[30]Ian Clarence Hope, "A Scientific Way of War: Antebellum Military Science, West Point, and the Origins of American Military Thought" (Ph.D. diss., Queen's University, 2011), esp. ch. 6; Molloy, "Technical Education and the Young Republic," 309–10; Compare with William B. Skelton, *An American Profession of Arms: The Army Officer Corps, 1784–1861* (Lawrence, KS: University Press of Kansas, 1992), ch. 8, 10.

descriptive geometry had emphasized visualization, and likely were conducted not only with visual aids but also with blackboards; Crozet and other colleagues at West Point subsequently made work at the blackboard into a central component of learning geometry.[31] As Davies, the longtime West Point instructor, noted in his *Logic and Utility of Mathematics*, the teaching of geometry should establish "a connection between the eye and the hand, and give, at the same time, a clear perception of the figure." Skill in both head and hand was supposedly made visible by cadets' actions at the blackboard. An 1824 report confirmed that "in the pure Mathematicks the evidence of their advances are derivable from the accuracy and rapidity of their operations upon the black board." The blackboard required students to display both intellectual reasoning and fine motor skills. The Board of Visitors in 1854 concluded that cadets' use of the board ensures:

> the eye is trained to accurate measurement of distances and proportions; the hand is rendered skillful in executing all the varied motions necessary to drawn lines, straight and curved . . . The mind itself, by this exercise, gains a new power over its thoughts, and becomes disciplined and strengthened for every practical work.[32]

Crozet's method provided the mechanism for training future officers' minds and bodies. The integration of head and hand was instantiated by descriptive geometry and cultivated by cadets' actions at the blackboard.

Cultures of Examination

Crozet initially used the blackboard to train students in descriptive geometry but subsequent instructors adopted the blackboard more generally because they also found that the board efficiently revealed cadets' intellectual, moral, and physical characteristics. By mid-century, the device was at the center of what had come to be known as the "West Point Method." As the 1854 visitors' report explained, "When a scholar is sent to the blackboard, with no assistance except a rule and a bit of chalk . . . he is thrown upon the resources of his own mind, and is compelled, as in the after duties of life he will be, to decide and act

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[31] Little is known about the extent of Monge's use of the blackboard but his textbook strongly suggests students would be expected to use rulers and compasses on similar surfaces: Monge, *Géométrie Descriptive*, x and 15.

[32] Charles Davies, *The Logic and Utility of Mathematics, With the Best Methods of Instruction Explained and Illustrated* (New York: A.S. Barnes and Co., 1850), 257; Board of Visitors Report, 1824, 116; Board of Visitors Report, 1854 (reprinted in Senate, *Message from the President of the United States to the Two Houses of Congress*, Part II, 33d Cong., 2d Sess. [Washington, DC: Beverly Tucker, 1854], 150).

independently." In a historian's evaluation a decade later, the blackboard was the most important of all the pedagogical tools at West Point: "it is on the blackboard where the workings of [a cadet's] mind are chiefly exhibited." Textbooks, papers, and written exercises were all subservient to oral examinations at the blackboard. While a cadet "learns what he can from the book," the professor can "trace out what [the cadet] has done" at the board and eventually "detects his weak place, and forces his mind (so far as such force is possible,) to *think*, and think rightly on the subject before him." A second historian, also writing in the 1860s, summed up the matter succinctly: "in every branch of study at the Military Academy, the blackboard is a ruling feature in the performance of each cadet." To an extent that would surprise even Crozet, blackboards became essential devices for disciplining and revealing cadets' abilities.[33]

West Point instructors primarily deployed the blackboard in the smallest of the Academy's spaces: the recitation rooms. After an instructor introduced a topic in lecture, he would examine students on that topic in the next day's recitation, at which students would stand at a blackboard and answer questions in front of a small group of their peers. "Sections" of eight to fourteen students would be assigned to each recitation, and although there is some evidence of individual recitations, most instruction occurred in a small group setting. No subject was allotted less than an hour each day, excluding Sundays; in mathematics, engineering, and natural philosophy the recitation involved at least an hour and a half.[34] Unlike recitations, Academy lectures were commonly ridiculed. In the case of the mathematics assistant Lieutenant Edward Ross, one former cadet, F. H. Smith, recalled that "the class was as ignorant when he closed as when he began." For a cadet like Smith, it was only in recitations that instructors shined. "In a series of orderly questions," Smith recalled that Ross would "bring out the points of discussion, step by step, sometimes occupying half an hour with each cadet, and when the three hours of recitation were over we knew the subject thoroughly. He was an expert in his power of questioning a class." Smith's recollections were not unusual. Recitations at the blackboard were the pedagogical heart of nineteenth-century West Point. Nevertheless, West Point did not invent the recitation; Crozet had very

[33] Board of Visitors Report, 1854; Mansfield, "United States Military Academy," 38; Edward C. Boynton, *History of West Point, and its Military Importance During the American Revolution and the Origin and Progress of the United States Military Academy* (New York: Van Nostrand, 1863), 272. For Crozet's lament about the eventual extent of examinations at West Point, see Hunter and Dooley, *Claudius Crozet*, 24.

[34] Board of Visitors Report, 1854, 149–50; Yale Prof. J.D. Kinsley mentioned that because he was not there for the public examinations he witnessed "private recitations of the Cadets," in Board of Visitors Report, 1824, 120.

likely been exposed to recitations as a student in France, and his mentor, Monge, had himself been a "répétiteur" as a young instructor. Rather, West Point faculty transformed recitations from an instructional technique into the dominant feature of an overall culture of examination.[35]

One corollary of this conclusion is that the blackboard's emergence at West Point was not a consequence of increasing class size. When lecturing to many students, instructors continued to use preprinted diagrams (some of which Crozet himself had brought from the École Polytechnique) throughout the century. The blackboard's emergence was also not a function of lack of access to paper—there is record of stationery provisions for cadets as early as the 1820s.[36]

The centrality of intimate, blackboard-based recitations at West Point was manifest in the built environment. The first recitations in the 1810s and 1820s had taken place in small rooms within the barracks with students likely sitting on benches against the wall until their turn at the board.[37] By the late 1830s, recitations had become enough of an established feature to be incorporated into the design of a new academic building. In addition to large exercise and "riding" halls on the first floor, a sizable chemical lab, and spaces for statues and models, the majority of rooms in the Academy's new building were devoted to recitations. Each of these "section rooms" had twenty-five-foot-long walls and eleven-foot ceilings, and were specifically designed for examining students at blackboards. Each room was outfitted with twelve to fourteen slates about four foot square, joined together on the walls in groups of four to five in order to form a blackboard. Each of these had a chalk tray in its oak frame with wire grating and brass racks for rulers and pointers below them. Two large windows framed the central blackboard and instructor's desk and provided light for the room.[38]

The daily recitations were crucial preparation for the important twice-yearly examinations, which also centered on students' performance at the blackboard. These formal examinations took place for

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[35]For Smith's recollections: Cajori, *Teaching and History of Mathematics*, 122 and 126; For recitations in France: Molloy, "Technical Education and the Young Republic," 16–18, 370. Recitations were commonly taught by assistants, but Dennis Hart Mahan, one of the most famous of West Point's nineteenth-century professors, apparently taught recitations himself: Griess, "Dennis Hart Mahan," 193–96.

[36]Board of Visitors Report, 1826, 6; Cajori, *Teaching and History of Mathematics*, 117; Board of Visitors Report, 1824, 104.

[37]Latrobe, *Reminiscences*, 9.

[38]While broadly similar, there are some minor discrepancies in the size and number of these early recitation rooms. For descriptions, see Boynton, *History of West Point*, 258; U.S. Department of the Interior, National Park Service, *Historic Structures Inventory, United States Military Academy, West Point, New York*, 4 vols. (Washington, DC: Historic American Buildings Survey/Historic American Engineering Record, 1984), 2:12; Tillman, "Academic History," 251–53.

days on end, from eight in the morning until seven at night, with only a break for lunch.[39] The exams were essentially high-stakes public recitations; the results determined whether a student knew the material well enough to move on to the next class level. Harvard professor George Ticknor vividly described his own 1826 visit to examinations at West Point in a letter to his wife. Reporting with other members of the Board of Visitors to the examination room at eight in the morning, Ticknor noted how superintendent Thayer (a close friend of Ticknor's) sat at one table with the faculty while the Board of Visitors and its chair, General S. Houston, sat at the other:

> In front of the last table two enormous blackboards, eight feet by five, are placed on easels; and at each of these boards stand two Cadets, one answering questions or demonstrating, and the other three preparing the problems that are given to them. ... The young men have that composure which comes from thoroughness, and unite, to a remarkable degree, ease with respectful manners towards their teachers.[40]

Given the audience and stakes, any "ease" surely was feigned, although cadets' daily recitations likely provided crucial exam preparation. Visitors could select their own questions to ask or choose which student should receive the faculty member's question, often focusing on the least able students to test the quality of instruction at the institute. The blackboard could be used in this sense as a tool for revealing the quality of cadets *and* instructors.[41]

Contemporaries considered oral recitations and examinations with blackboards the primary technology for inculcating mental discipline. An 1854 visiting committee noted that the recitations "afford[ed] the professor or instructor ample opportunity to question every cadet minutely; to impart to him clear ideas if he is confused; and to drill him thoroughly at the blackboard. We hesitate not to say, that no other institution in our land, within our knowledge, affords such facilities for perfect drill and complete instruction as this. The practice of training students to the daily use of the chalk and the blackboard cannot be too highly commended."[42] Students and faculty alike recognized that this mechanism of assessment was only partially about the demonstration of specific knowledge. A member of the class of 1869 recalled two decades later that in his own sections, the professor was a "stickler for form–it was not enough to *mean* right" for the "mathematical recitation at

[39] E.g., Board of Visitors Report, 1824.

[40] George S. Hillard and Anna Ticknor, eds., *Life, Letters, and Journals of George Ticknor*, 2 vols. (Boston, MA: James R. Osgood and Company, 1876), 1:374; partially quoted in Dupuy, *Where They Have Trod*, 166–67.

[41] Board of Visitors Report, 1847.

[42] Board of Visitors Report, 1854, 203.

West Point was a drill-room." Particularly appalling was the fact that even though the Academy collected geometric models that might have aided comprehension, they were not shown to students until after examinations. "In other words," he lamented, "mental discipline was the object—practical helps and ends were secondary."[43]

In fact, the blackboard's development as an educational technology reveals the particular way Academy faculty interpreted the meaning of mental discipline in this period. For example, when faculty claimed in 1843 that the Academy ensured the "reasoning facilities" of cadets had been "strongly exercised and disciplined," they were drawing in part from the same principles espoused by contemporaries at Yale. In the course of emphasizing the importance of a curriculum that exercised specific mental faculties, the Yale Report of 1828 grounded the study of the traditional liberal arts, including mathematics, in the concept of "faculty psychology." In and of itself, this is not remarkable—as Michael Pak has emphasized, "mental discipline" and "faculty psychology" were well-respected "educational orthodoxies," embraced by both educational reformers and traditionalists. Claiming the blackboard was a tool of mental discipline indicates very little. Rather, what is most relevant is the way the blackboard represented and inculcated a specific notion of mental discipline appropriate for future officers.[44]

When, for example, Birdsey Northrop of the Massachusetts Board of Education visited the Academy in the 1860s, he found "one of the learned professors occupying a full half-hour in elucidating a single point in geometry to a cadet" at the blackboard.

> "Do you now fully understand it?" inquired the professor. "Yes, sir," replied the cadet. "Then demonstrate it," was the answer. The work was promptly done; but an error was discovered, and pointed out. "Try again, sir," [t]he work was erased and quickly repeated. "You have the right result, sir, but you have omitted one step which vitiates the whole demonstration. Try again, sir."

Officers needed more than just the right result. Northrop was impressed with the "patient drilling of individuals," ensuring both answer

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[43] Quoted in Cajori, *Teaching and History of Mathematics*, 124.

[44] The faculty quotation is from Tillman, "Academic History," 245; Michael S. Pak, "The Yale Report of 1828: A New Reading and New Implications," *History of Education Quarterly* 48, no. 1 (February 2008): 30–57, esp. 34. More generally, Jack C. Lane, "The Yale Report of 1828 and Liberal Education: A Neorepublican Manifesto," *History of Education Quarterly* 27, no. 3 (Autumn1987): 325–38, esp. 333; Jurgen Herbst, "The Yale Report of 1828," *International Journal of the Classical Tradition* 11, no. 2 (Fall 2004): 213–31. A comparison between the approaches of Yale and West Point was made explicitly in Morrison, *"Best School in the World,"* 104–105. For mental discipline's later history, Walter Bernard Kolesnik, *Mental Discipline in Modern Education* (Madison, WI: University of Wisconsin Press, 1958).

and presentation were adequate, and understood such practices to be "ordinary" at West Point.[45]

Unlike some later incarnations of recitations, West Point's version did not simply entail rote learning.[46] The Academy's "patient drilling" involved a back and forth between examiners and cadets, and examiners took pride in questioning every assertion, mark, and claim. In particular, the discipline of mathematics recitations did not primarily emerge from the regurgitation of memorized theorems or the solution of increasingly complicated mathematical problems—characteristics associated with the near-contemporaneous invention of written mathematical exams in English universities.[47] As one former cadet explained, at the blackboard the "thorough understanding of the subject given him is determined, while memory is thereby rendered subservient to the powers of reason." The recitation system meant that cadets covered only a few pages of new material at a time, and were constantly directed to interrogate underlying principles and assumptions. The most common question for the blackboard recitation was: "Why?"[48] Perhaps surprisingly for a military institution, thoughtful understanding and careful explanations were valued above rote call and response answers.

That is, West Point's version of recitations was not about efficiency in learning content but about changing mental habits: as longtime instructor (and former cadet) Peter Michie recalled, "day by day these exactions on the part of the instructor became less formidable; we corrected our habits, modified greatly our imperfections, and soon were able to make a clear and intelligent demonstration." While recitations bore a family resemblance to contemporary innovations like the Lancasterian (or monitorial) system of primary school education, recitations at West Point were not just a method of classroom management. They were tools for revealing cadets' characters.[49]

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[45] Birdsey Northrop, "The United States Military Academy at West Point," Massachusetts Board of Education, *Twenty-Seventh Annual Report* (1864), 90–124, on 98.

[46] The recitation, in its long history, has entailed many different versions, see, V.T. Thayer, *The Passing of the Recitation* (Boston, MA: D.C. Heath and Company, 1928), 4–12.

[47] See Warwick, *Masters of Theory*, esp. ch. 3.

[48] Board of Visitors Report, 1854; Peter S. Michie, "Educational Methods at West Point," *Educational Review* 4 (1892): 350–65, on 356; Sidney Forman, "Cadet Life Before the Mexican War," *Bulletin of the Library, United States Military Academy* 1 (1945): 1–26, on 15.

[49] Michie, "Educational Methods at West Point," 355; On the explicit interdependence of moral and mental, see Peter S. Michie, "Education in its Relation to the Military Profession," *Journal of the Military Service Institution of the United States* 1 (1880): 154–79, on 168. For Lancasterian schools, see Kaestle, *Pillars of the Republic*, 41 and Kaestle, ed., *Joseph Lancaster and the Monitorial School Movement: A Documentary History* (New York: Teachers College Press, 1973).

Habits of Character and Comportment

The blackboard was part of the machinery of West Point's regime of mental discipline. When Ticknor cited cadets' "composure" and "manners" and Michie spoke of "our habits," both were hinting at the interrelationship of mental, moral, and physical discipline in an institution training both engineers and officers. Indeed, the examinations at the blackboard were as much about physical and moral characteristics as about knowledge acquisition. Visitors repeatedly commented not just on the intellectual ability of the cadets but also on their physical comportment. One subcommittee on instruction in 1849 described command of both mind and muscles at the board: "their firm, erect, and manly bearing; the entire absence of all fidgeting and restlessness, of shuffling and shrugging, of shifting their weight from foot to foot . . . these and similar characteristics of self dependence and manliness have been, in the highest degree, remarkable and creditable." Likewise, other visitors noted the speech patterns of cadets, with a "rich elocution" revealing "a facility and perspicuity of expression and illustration." When less successful, cadets were warned that "indistinct" speech would continue to be a problem when they eventually assumed officerships for which "the tone of the voice would be one of the most potent means of inspiring confidence."[50] The way in which a cadet presented the material at the board revealed both his clarity of thought and his ability to confidently command authority.

Official accounts of the Board of Visitors as well as cadets' memoirs emphasized the interdependence of mental and physical discipline in West Point's blackboard-based recitations. Michie described the effect of recitations by noting that "bit by bit a manliness of character and a mental structure are being reared which rest upon the sure foundation of knowledge, reaching down to first principles."[51] The West Point cadet F. H. Smith pointed to the ways this sure foundation was not simply about knowing facts. His mathematics instructor, Ross, had asked Smith to simplify a complicated algebraic expression on the board. Smith attempted to do so and after explaining his work, step by step, Ross ended with the pronouncement that, "It's all wrong, sir." Working again on the board in front of the group but emerging from the calculations with precisely the same answer, Smith recalled that "I became desperate, and in this state I said to him in a firm but nervous tone: '*My result is right, sir*.'" To which he recalled Ross replying, "It is right, and it was

[50]For manly bearing: Board of Visitors Report, 1849; Rich elocution: Board of Visitors Report, 1824; Indistinct speech: Board of Visitors Report, 1849.

[51]Michie, "Education in its Relation to the Military Profession," 166.

right before, why didn't you *stick* to it?"[52] In the face of pressure, Smith had the math right but the self-confidence wrong. Oral examinations and recitations, unlike their written counterparts, required students to display moral fortitude in addition to the correct answer. One needed both head skills and hand skills to excel, and recitations at the blackboard furnished an ideal mechanism for cultivating those skills.[53]

The blackboard made visible and accountable the moral, physical, and intellectual constituents of officer training, and its origins at West Point should be understood within Thayer's broader initiative to "insure method, order, and prosperity to the institution."[54] The Academy's general regulations were—of course—indicative of the presumption that officers required certain physical *and* moral characteristics. To be admitted, students had to pass a basic test of reading, writing, and arithmetic as well as demonstrate that they were within a specific height and age range, were free from a lengthy list of possible impairments, including varicose veins, ulcers, and hernia, and were "free from any disorder of an infectious or immoral character."[55] Cadets who had managed their habits well enough to be admitted had to regulate their bodies upon arrival according to precise schedules specifying behavior nearly every minute of every day. The underlying philosophy was, as the Massachusetts educator Northrop recounted, "all history shows that the man who is negligent in obvious minor duties, is unreliable in great emergencies. He who is personally and habitually negligent of the minutiæ of his calling, can poorly enforce the needful attention to details upon those under his command."[56] Contemporaries echoed Northrop's assertion of the importance of the careful regulation of conduct for the ability to command subordinates—governing oneself was believed to be the best preparation for managing nineteenth-century soldiers.[57]

These minute regulations naturally extended down to conduct at the blackboard itself. Regulations required that students stand at

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[52] Francis H. Smith, *West Point Fifty Years Ago* (New York: Van Nostrand, 1879), 10.

[53] For the contemporaneous case of Britain and the origin of the "head and hand" dichotomy, see Steven Shapin and Barry Barnes, "Head and Hand: Rhetorical Resources in British Pedagogical Writing, 1770–1850," *Oxford Review of Education* 2, no. 3 (1976): 231–54.

[54] Boynton, *History of West Point*, 218–19; Slightly misquoted in Cajori, *The Teaching and History of Mathematics*, 114; Hunter and Dooley, *Claudius Crozet*, 19–21; Mansfield, "United States Military Academy," 30.

[55] "Regulations Relative to the Admission of Cadets into the Military Academy," reprinted in Mansfield, "United States Military Academy," 47–48.

[56] Northrop, "United States Military Academy," 105.

[57] For example, Mansfield, "United States Military Academy," 39; Boynton, *History of West Point*, 276.

attention on the side of the board farthest from the central line of the room; hold the pointer in the hand nearest the board with point downward unless in active use; face the instructor when speaking; and refrain from unnecessary motions or "nervous habits." Rules specified every movement, with students at the front boards working on the main lesson for the day as students at the side boards demonstrated applications or particular solutions using those lessons. According to the regulations, each student began his board work by writing his name on the upper-right-hand corner of the blackboard and then proceeded to write his answer while the instructor orally quizzed any students not currently scribbling. Once a student at the board finished writing, he then stood at attention with his pointer in hand, awaiting the command to explain his work.[58]

Tellingly, the blackboard was not a place for mistakes. No extraneous writing was allowed on the board and the eraser could only be used with permission of the instructor. One's mind had to be ordered prior to approaching the blackboard, or at least one had to possess the ability to think quickly enough for it to appear so. If the blackboard made cadets' minds visible, minds ideally both decisive and accurate, it was not a place for experiments or trials.

The regime of examination and recitation at the blackboard should be understood as one component of the Academy's culture of constant surveillance. The report of a visiting brigadier general in 1822 emphasized this principle: "the Cadets are emphatically the Children of the Government, and should be watched over with the eye of paternal care." Boynton recalled that "in whatever situation a Cadet may be placed, he is observed by some superior." The goal of this "close supervision" was to ensure that "military deportment" became "insensibly a fixed habit." Visitors approvingly noted that "a careful police is constantly maintained." This was done through the vigilant monitoring of cadets. Just as recitations made cadets' abilities legible on the blackboard, so this surveillance made cadets' behavior apparent to all. Instructors entered deviations, even minor ones, into a "day book," which was then read aloud to the entire Academy, sent to parents, and posted in the Department of War in Washington, DC. Recitation sections reflected similar rankings, with the Academy placing top students into the first section, and grouping subsequent sections similarly. Students moved between sections constantly as they moved in the rankings, making visible one's relative standing in the very sections one attended.[59]

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[58]Recitation regulations were reprinted in Tillman, "Academic History," 252–57.

[59]Board of Visitors Report, 1822 and 1826, 5–6; Boynton, *History of West Point*, 272, 279–80; Letter of Prof. Arthur S. Hardy, quoted in Cajori, *Teaching and History*

The ranking of cadets into distinct levels was not surprising for a military institution, but again emphasized the ways moral, intellectual, and physical achievements were intertwined. Following the "rule of recitation," an examination would be given to "every man in every subject daily," and the performance scored by the instructor.[60] Faculty mingled the moral and the intellectual in their evaluations: most significant were conduct, engineering, mathematics, and natural philosophy; followed by practical military instruction, geography, chemistry, history, and moral science; and finally French and drawing. Students cared deeply about the resulting "merit-roll" ranking, mainly because it determined the ability to choose one's career following graduation.[61]

The blackboard formed a crucial component of West Point's overall disciplinary program. Looking back years later, the former cadet Mansfield concluded, "discipline is *training* in knowledge and virtue, in order and diligence, in good conduct, and good habits. To do this requires a control of the body as well as of the mind; of food and raiment; of time and exercise; as well as the imparting of facts and ideas." Bodily management and intellectual achievement were both constitutive of disciplined students. Observers compared the Academy's success to peer institutions that had failed to restrain young people adequately. As early as 1823, a member of the Board of Visitors noted that Cadets submitted "with cheerful and manly deportment to the strict discipline" of the school while another visitor that year noted the "discipline of the Academy is stern" and "rigidly maintained." The sentiment was hardly limited to this one particular visit. Three years later, the visitors' report praised the system of discipline as "skilfully [*sic*] adapted to its object."[62]

The discipline of the blackboard, like that of descriptive geometry, was contextualized within the specific institutional culture and aims of West Point. That is to repeat the point that the recitations and examinations were not primarily about conveying subject matter, but about cultivating future officers. If the blackboard's West Point origins were tied to the need to visualize descriptive geometry, the blackboard eventually served a much broader goal, making visible the intellectual, physical, and moral attributes of cadets. The blackboard

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of Mathematics, 124. West Point was, again, following in the path of the École Polytechnique: Janis Langins, "The Ecole Polytechnique (1794–1804): From Encyclopaedic School to Military Institution" (Ph.D. diss., University of Toronto, 1979), 256–57.

[60] Dupuy, *Where They Have Trod*, 163. While most sources describe evaluation scores ranging from 0 to 3, one mentions them as ranging from –3 to 3: Mansfield, "United States Military Academy," 40. Not surprising, this idea of the constant grading was also French in origin: Molloy, "Technical Education and the Young Republic," 124.

[61] *General Regulations for the Army*, 336–37; Board of Visitors Report, 1821, 31.

[62] Mansfield, "United States Military Academy," 38; Board of Visitors Report, 1823; Board of Visitors Report, 1826.

prepared students for the demands of civil and military engineering; shaped confident officers with skills of clear speech and coolness under constant pressure; and forged students able to make and then stand by decisions in the midst of war.

Disciplinary Technologies

Although West Point's disciplinary regime was explicitly geared toward military training, contemporaries also understood it as a model for social order. Under the purview of the Department of War, the United States Military Academy was one of the major investments of federal monies in postsecondary education in antebellum America. Early supporters conceived West Point as a national institution and a crucial component of establishing a democracy able to stand separately from Britain. Likewise, political leaders hoped a properly constructed institution might combat sectionalism and address shortages in the ranks of civil and military engineers even as it tempered the potential dangers a standing army posed to republican liberties. In the early- to mid-nineteenth century, the country's military functioning had not been clearly divided from the civilian bureaucracy. West Point's establishment occurred among substantial debate about the size and role of the military, and the relationship between military and political elites. It was not clear in the early decades of the Academy that a standing militia, let alone a school for the production of officers, was in fact a good idea. West Point was more than a small school for officers; it was a plausible model for disciplined, moral, republican education generally.[63]

Many early nineteenth-century Americans recognized this broader significance of the West Point method. In a period of widespread student unrest at the college level, West Point's model of disciplinary education stood out. Parents, even ones skeptical of the worth of a standing army, would be willing to send their sons to West Point because they

[63] On debates surrounding the Academy's founding see McDonald, ed., *Thomas Jefferson's Military Academy*; Molloy, "Technical Education and the Young Republic"; Griess, "Dennis Hart Mahan," ch. 1; and Joseph B. James, "Life at West Point One Hundred Years Ago," *The Mississippi Valley Historical Review* 31, no. 1 (June 1944): 21–40, on 28; Theodore J. Crackel, *Mr. Jefferson's Army: Political and Social Reform of the Military Establishment, 1801–1809* (New York: New York University Press, 1987), 13; Rudolph, *American College and University*, 42; and more broadly, Sean Wilentz, *The Rise of American Democracy: Jefferson to Lincoln* (New York: W.W. Norton & Company, 2005), esp. 129, and John C. Scott, "The Mission of the University: Medieval to Postmodern Transformations," *The Journal of Higher Education* 77, no. 1 (January/February 2006): 1–39, on 15. The Civil War provided a stark challenge to West Point's attempt to transcend sectionalism: James L. Morrison, "The Struggle Between Sectionalism and Nationalism at Ante-bellum West Point, 1830–1861," *Civil War History* 19, no. 2 (June 1973):138–48.

believed it provided the discipline needed for effective citizenship.[64] The Academy also gained political strength in antebellum America by supplying many of the nation's civil engineers and mathematically skilled surveyors during a period of rapid expansion and construction across the continent. Nevertheless, West Point faculty resisted new developments at peer institutions of scientific and mathematical education, which included research seminars and highly technical written exams.[65] Over the course of the nineteenth century, West Point appeared increasingly anomalous, as the institution's faculty claimed the Academy indeed enjoyed a special place among American colleges, technically open to many but geared to develop leaders based on virtue and talent, not wealth or birth. This required careful attention to both entrance requirements and curriculum organization; recruitment was nationwide but many potential cadets were turned away and high attrition rates ensured there would be constant awareness of the risk of failure. In practice, according to Mansfield, "the very first thing done at West Point is to *recognize* the fact, that *intellects are unequal*."[66] In an era of great debate concerning the place of elites (especially military

[64]The literature on student unrest is surveyed in Roger L. Geiger, "Introduction," in *The American College in the Nineteenth Century*, ed. Roger L. Geiger (Nashville, TN: Vanderbilt University Press, 2000), 1–36 esp. 10–11 and in Rodney Hessinger, "'The Most Powerful Instrument of College Discipline': Student Disorder and the Growth of Meritocracy in the Colleges of the Early Republic," *History of Education Quarterly* 39, no. 3 (Autumn 1999): 237–62; For the political significance of contemporary unrest at Dartmouth, see Jane Fiegan Green, "'An Opinion of Our Own': Education, Politics, and the Struggle for Adulthood at Dartmouth College, 1814–1819," *History of Education Quarterly* 52, no. 2 (May 2012): 173–95. For parental views of West Point, see, for example, Letter to John Latrobe from his father quoted in Semmes, *John H.B. Latrobe and His Times*, 67–69. In fact, there is some evidence that West Point's method did not "work" reliably, in that final rankings of cadets did not correlate strongly with distinction in career as officers. *Not* finishing in the top of one's class, though, did make it unlikely that a student would become an engineer or scientist. See Molloy, "Technical Education and the Young Republic," 440.

[65]Arney, *West Point's Scientific 200*; Ambrose, *Duty, Honor, Country*, 117–24. For developments elsewhere, see Warwick, *Masters of Theory*; Gillispie, *Science and Polity in France*, 536–37; Molloy, "Technical Education and the Young Republic," 57–58, 113, 117; Ronald Calinger, "The Mathematics Seminar at the University of Berlin: Origins, Founding, and the Kummer-Weierstrass Years," in *Vita Mathematica: Historical Research and Integration with Teaching*, ed. Ronald Calinger (Washington, DC: Mathematical Association of America, 1996), 153–76; Parshall and Rowe, *The Emergence of the American Mathematical Research Community*.

[66]Quotation from Mansfield, "United States Military Academy," 37 (emphasis in original); On attrition rates see, for example, Board of Visitors Report, 1826; On the problem of elites: Crackel, *Mr. Jefferson's Army*, 61, 73, and Theodore J. Crackel, "The Military Academy in the Context of Jeffersonian Reform," in *Thomas Jefferson's Military Academy*, 99–117. On the high failure rates even on the relatively straightforward entrance examination and requirements, see Michie, "Education in Its Relation to the Military Profession"; John E. Semmes, *John H.B. Latrobe and His Times, 1803–1891* (Baltimore, MD: Norman, Remington Co., 1917), 74; Ambrose, *Duty, Honor, Country*, 128–29.

leaders) within a democratic republic, and of concerns about the role of a standing army and the scientific problems posed by rapid territorial expansion, West Point's pedagogical methods were noted far beyond its walls.

On its surface, West Point is a near perfect illustration of Michel Foucault's analysis of institutional transformations more broadly around 1800. Many—if not all—of the themes Foucault mentioned as characteristic of the new "disciplinary society" were precisely those refined at West Point—uninterrupted examinations, visible and constant rankings, emphasis on well-disciplined bodies and carefully regulated gestures, grounding of the military study of "tactics" in disciplinary practices, and, above all, desire for complete management of bodies, spaces, and minds.[67] Foucault chose to examine the institution of Mettray and the design of the Panopticon—in part because of his focus on the human, rather than physical, sciences—but he might just as perceptively chosen to look at the École Polytechnique or the United States Military Academy. The latter, unlike its French ancestor, in fact, remained a model "disciplinary institution" far longer; the Polytechnique was continually buffeted and reformed by new intellectual and scientific developments and the changing winds of political fortunes.[68] West Point, with its stagnant faculty and conservative curriculum, enjoyed remarkable stability throughout the nineteenth century.

The role of the blackboard at West Point and the Academy's pedagogical machinery should not, however, be reduced to a Foucauldian case study. Many historians have traced how institutions in this period incorporated material, institutional, and intellectual support for cultivating specific ideas of "discipline."[69] Following the suggestions of David Kaiser and Andrew Warwick, the lesson of Foucault's analysis of

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[67] These themes can be found throughout Foucault's later writings, but take on particular force in Michel Foucault, *Discipline and Punish: The Birth of the Prison*, trans. Alan Sheridan (New York: Vintage Books, 1977 [1975]), esp. 146–209.

[68] Some disagreement exists on the causes of these changes, but there is no doubt that there was a significant shift in the emphasis of education at the École Polytechnique: Charles Gillespie, "Un Enseignement Hégémonique: Les Mathématiques," in *La Formation Polytechnicienne*, 31–43; Belhoste, "Un Modèle à l'Épreuve."

[69] For a wider scope of Foucault's relevance to education see, for example, Michael A. Peters and Tina (A.C.) Besley, ed, *Why Foucault: New Directions in Education Research* (New York: Peter Lang, 2007) and Kate Rousmaniere, Kari Dehli, and Ning de Coninck-Smith, eds., *Discipline, Moral Regulation, and Schooling: A Social History* (New York: Garland Publishing, 1997); For some of the relevant literature in history of early nineteenth-century education, Hessinger, "The Most Powerful Instrument of College Discipline"; David Hogan, "The Market Revolution and Disciplinary Power: Joseph Lancaster and the Psychology of the Early Classroom System," *History of Education Quarterly* 29, no. 3 (Autumn 1989): 381–417; Carl F. Kaestle, "Social Change, Discipline, and the Common School in Early Nineteenth-Century America," *The Journal of Interdisciplinary History* 9, no. 1 (Summer 1978): 1–17.

educational institutions may well be the *productive* effects of constraints and norms.[70] Thayer described the reforms he instituted, through instructors like Crozet, as ones intended to "regulate and harmonize the whole machine of instruction."[71] The blackboard, along with the supporting curriculum, examinations, and regulations, emerged within a specific institutional context, a "machine of instruction" geared to produce a particular form of "mental discipline." The blackboard was exceptionally well suited to the task, as a surface through which cadets could cultivate desired mental habits and as a tool with which instructors could test comportment and moral fortitude.

Despite its origins in the peculiar militaristic milieu of West Point, the use of the blackboard spread widely across the United States and flourished in new settings and with new purposes. Because the Academy enjoyed prominence as a place to receive a disciplined and rigorous education, its pedagogical elements, like blackboard-based recitations, gained notice accordingly. West Point's methodology and its technologies were also publicized through the Board of Visitors, which brought influential educators from around the country—including Massachusetts's Horace Mann and Connecticut's Henry Barnard—to observe and then promote the pedagogical methods of the Academy. Another significant factor in the spread of the blackboard came from a West Point graduate and instructor, Nicholas Tillinghast, who became the principal of the Bridgewater Normal School in Massachusetts. One of the first institutions of its kind in the country, the Bridgewater Normal School disseminated pedagogical methods and techniques to teachers across New England. Beginning in 1840, Tillinghast took over the school and was able to promote the use of the blackboard and the corresponding system of oral examination.[72] Confirming the influence of Academy educators on the broader use of the blackboard, Massachusetts's Northrop concluded after his visit in the 1860s that "if West Point had done nothing else, it would not be easy to estimate the value to the cause of public instruction of the blackboard, the cheapest, the most used and the most useful of all educational apparatus, and also of the West Point method."[73]

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[70] Andrew Warwick and David Kaiser, "Conclusion: Kuhn, Foucault, and the Power of Pedagogy," in *Pedagogy and the Practice of Science*, ed. David Kaiser (Cambridge, MA: MIT Press, 2005), 393–409.

[71] Thayer quoted in Samuel J. Watson, "Developing 'Republic Machines': West Point and the Struggle to Render the Officer Corps Safe for America, 1802–1833," in *Thomas Jefferson's Military Academy*, 154–81 on 168.

[72] Richard Edwards, *Memoir of Nicholas Tillinghast, First Principal of the State Normal School at Bridgewater, Mass.* (Boston, MA: James Robinson & Co., 1857), esp. 11–16.

[73] Northrop, "United States Military Academy," 99.

Although historians have not extensively traced the mechanisms by which the blackboard spread, it is clear that by mid-century, the scattered references to blackboards in New England journals of education had turned into a continuous stream of full-fledged treatises proselytizing for its use in schools.[74] Reformers pushed for teachers to use blackboards in their classrooms and by the 1880s, the *Dictionary of Education and Instruction* reported that the device was commonly used in every grade, from elementary school to college, and nearly every subject. Significantly, the emphasis for many of these advocates was now primarily on the blackboard's relevance for ocular demonstration to a large group of pupils, not for small group recitations.[75]

However ubiquitous and diverse its later deployment, the blackboard had American roots in a very specific pedagogical regime, the leaders of which assumed it was a useful tool for revealing students' minds and moral characters. This assumption remained plausible and flexible enough that by 1880, the Andrews catalog could sell the device as a "mirror" of the mind to institutions wholly unlike the Academy, and which would go on to use it in entirely different ways. The history of the blackboard consequently warns against presuming that there is an unambiguous or unidirectional way technologies structure historical actors' experience or agency.[76] Blackboards are not "naturally" temporary display devices for large lecture halls any more than they are "naturally" instruments for testing the mettle of future officers. Rather, they are always situated among contingent premises.

The blackboard's West Point origins were closely tied to the nature of a postrevolutionary officer-training school, and to the

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[74]Kidwell, "An Erasable Surface"; a couple of early references are mentioned in Fletcher B. Dresslar, "Blackboards," 390–94 in vol. 1 of Paul Monroe, ed., *A Cyclopedia of Education* (New York: Macmillan Company, 1911), on 391; Treatises from the 1840s include Josiah F. Bumstead, *The Blackboard in the Primary School* (Boston, MA: Perkins & Marvin, 1841); John Goldsbury, *Exercises and Illustrations on the Blackboard; Furnishing an Easy and Expeditious Method of Giving Instruction* (Keene, NH: George Tilden, 1847); and William A. Alcott, *Slate and Blackboard Exercises* (New York: Mark H. Newman, 1843).

[75]Henry Kiddle and A.J. Schem, *Dictionary of Education and Instruction* (New York: E. Steiger & Co., 1881), 41.

[76]See Bruno Latour, "Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts," in *Shaping Technology/Building Society: Studies in Sociotechnical Change*, eds. Wiebe E. Bijker and John Law (Cambridge, MA: MIT Press, 1992), 225–58 and Langdon Winner, "Do Artifacts Have Politics?" in *The Whale and the Reactor: A Search for Limits in an Age of High Technology*, ed. Langdon Winner (Chicago, IL: University of Chicago Press, 1986), 19–39. This case study also provides historical grounding to some of the philosophical debates surrounding so-called "extended cognition," for example, Richard Menary, ed., *The Extended Mind* (Cambridge, MA: MIT Press, 2010).

establishment of a particular ideal of mental discipline. At a time of changing conceptions of educational institutions and new mechanisms of moral education, West Point's prominent deployment of the blackboard played a key role in these wider transformations. Blackboards were indeed at the center of nineteenth-century American classrooms.