Fighting Engineers: 
The U.S. Navy and Mechanical Engineering, 1840-1905

Brendan Patrick Foley  
MA, American History, Tufts University  
MSc, Maritime Archaeology, University of Southampton

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Program in the History and Social Study of Science and Technology  
June 2, 2003  

Certified by  

David A. Mindell,  
Associate Professor of the History of Engineering and Manufacturing  
(STS)

Merritt Roe Smith, Professor of the History of Technology  
(STS)

Rosalind H. Williams, Professor of Writing  
(STS)

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Fighting Engineers: The U.S. Navy and Mechanical Engineering, 1840-1905

Brendan Foley
PhD - History and Archaeology of Technology

Thesis Supervisor – Professor David A. Mindell
Program in Science, Technology, and Society
Massachusetts Institute of Technology
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Fighting Engineers examines social conflict as the cause of the formation of professional mechanical engineering in the nineteenth century U.S. Navy. In the middle of that century, the Navy began to utilize steam engines for motive power. Navy administrators recognized the need for engineering officers to design and operate ships’ steam power plants, but the social and political status of staff engineering officers was unclear. Their rank was relative to line officers, the men who navigated the ship and commanded the crew. Engineers possessed no legal command authority. This created problems as engineers’ responsibilities increased during the Civil War.

In response to shortcomings evident in the training of the engineer corps during the Civil War, the U.S. Naval Academy in the postwar period designed an unprecedented technical curriculum. Through this program, the Navy trained the nation’s first group of modern mechanical engineers. As Navy engineers built their profession after the war, they attempted to redefine what it meant to be a naval officer. The officer ideal moved from the aristocratic warrior of the anteBellum period to a college educated, scientifically minded professional late in the century.

To maximize the political utility of their technical expertise, Navy engineers had to spread their idea of mechanical engineering and engineering education to a broader audience. In the 1880s, they chose to do so in an unprecedented way. They promoted legislation that allowed them to serve as engineering professors at American universities. This foray into academia was a continuation of the long-standing government policy of internal improvements and federal technology sponsorship.

The U.S. Navy developed a distinct form of professional mechanical engineering practice in the late nineteenth century. As Navy engineers became professors and industrialists, they transmitted Navy engineering throughout the nation. The human products of that engineering style were a new generation of professional engineers. They were the foundations upon which America erected the modern industrial economy.
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Sometimes epiphanies occur in the midst of conversations with others interested in similar topics, as was the case with this thesis. The kernel formed in my mind during an extremely stimulating reading seminar on nineteenth century naval technology conducted by Professor David A. Mindell, my primary advisor. In conversation one afternoon in the fall of 1998, David, fellow graduate student Timothy Wolters, and I discussed the impact of the Civil War on engineering. We realized that very little had been written regarding the war's technological ripple effects in the post war period, about the diffusion of thousands of experienced steam engineers from the naval fleet to the civilian sector. Thanks to David and Tim, that afternoon I found my thesis topic. My ideas matured during continued conversations with those two fine scholars, and through their comments on early drafts of this document.

Over the past six years, David Mindell and I have traveled through several countries, sailed half a dozen seas, and spent hundreds of hours talking about the nineteenth century Navy, the Civil War, and countless other topics. From him I have learned to think critically, to argue persuasively, and to collaborate with other scholars. I have been extremely lucky to find an advisor who is instructor, mentor, advisor,
shipmate, and friend. Thanks, David; I am looking forward to many more years of fruitful collaboration.

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Chapter One – Introduction

In the summer of 1921, Secretary of the Navy Edwin Denby received a letter from the Dean of Mechanical Engineering at University of Michigan. Professor Mortimer Cooley’s lighthearted introductory comments showed that he and “Ned” were old friends; Cooley offered to tell the Secretary “how to run the Navy.” Cooley then proceeded to suggest an officer to relieve the Chief of the Bureau of Steam Engineering, noting that he hoped his interference would not embarrass Denby. The professor’s last bit of advice concerned professional training of officers. “Today in our universities the teacher is too often valued on his ability to impart knowledge with the least possible mental effort by his students…. Don’t ever permit the Naval Academy to copy too closely after civil institutions of learning,” Cooley admonished. “It is infinitely better to give the cadets a thorough drubbing on fundamentals and later give them post graduate work. But that is another story….”1

A Midwestern engineering professor telling a cabinet member how to do his job might have seemed impudent. However, government officials often solicited Mortimer Cooley’s advice, and Denby received the letter warmly. Cooley was an expert on matters of naval engineering. He was an 1878 graduate of the Naval Academy’s engineering program, in Cooley’s opinion “the finest course in mechanical engineering offered anywhere.”2 He had served in the fleet for years before opting for an academic career.

2 Letter, “Cooley to Denby” (23 August 1921).
Along with many other veteran Navy engineers, Cooley was a well-known figure in circles of power.

By the beginning of the twentieth century, Cooley and a close-knit group of fellow Navy engineers held influential positions in America. Several, like Cooley, were deans at or presidents of respected universities. Others controlled portions of industrial empires, including Westinghouse, General Electric, Allis-Chalmers, and Bethlehem Steel. In their post-service careers, these men took from the Navy a distinctive form of mechanical engineering knowledge and bequeathed it to the nation.

By the time Cooley penned his note to Denby, professional training for American mechanical engineers had gelled into a potent mixture of fundamental sciences, advanced mathematics, physical theory, and practical skills. It was a major component in America’s growing industrial might, and it differed from the engineering practice of European countries. The federal government was the sponsor of professional mechanical engineering’s development. Instructors at the United States Naval Academy at Annapolis created that body of knowledge in the decades following the Civil War.

**Theme One – Federal Sponsorship**

There are two main themes in this dissertation. The first is the American federal government’s sponsorship of new technology. This dissertation argues that the U.S. Navy developed the profession of mechanical engineering through the nineteenth century. Creation of technical artifacts such as steam engines and turbines were one aspect Navy engineering endeavor. Far more important was the formation of a body of professional
knowledge. I trace Navy mechanical engineering’s path toward professionalization through four phases of development.

**Phase one** - In the antebellum period, civilian expertise in steam engineering was more advanced than Navy know-how. Accordingly, the Navy purchased ships, engines, and designs from civilian contractors.

**Phase two** - During the Civil War, engineers of the Bureau of Steam Engineering laid claim to expert knowledge based on scientific method. Thereafter Navy engineers took a much larger role in engine design, edging out civilian engineers.

**Phase three** - After the war, Navy engineers solidified their expert status, and began to transfer new skills to the private sector through universities.

**Phase four** – At the end of the century mechanical engineering knowledge dissemination from the Navy to civilian institutions was complete. Experts in universities and industry again outstripped Navy engineering, and as in the 1840s the Navy began to purchase ships, engines, and designs from civilian contractors.

**Theme Two - “Fighting Engineers”**

The title of this dissertation is drawn from comments made by Assistant Secretary of the Navy Theodore Roosevelt at the turn of the century. The Bull Moose stated, “Every officer on a modern war vessel has to be a fighting engineer.” He made this comment in support of a bill to reorganize the personnel of the Navy, called the Line and Staff Amalgamation Plan. The bill was designed to integrate the Navy’s staff officers in the engineer, medical, and paymaster corps with the executive branch of the fleet, the

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line. The separation of line and staff officers in the Navy had long created problems. In the 1840s, the medical corps argued for the authority and privileges of actual rank, instead of the relative rank that left them subservient to even the most junior line officer.\(^4\) In the 1860s, engineers and paymasters joined the surgeons’ appeal.

When Roosevelt used the term “fighting engineers,” he meant it in a combat sense. In some cases earlier in the century, this was applicable to the staff corps. For instance, during the Mexican War, Navy engineers disembarked to lead troops in engagements with the enemy on land. The engineers of the 1840s were every bit as much combatants as the line officers they served beside.

The phrase ‘fighting engineers’ is applied elsewhere in this dissertation. Through most of the pages that follow, the adjective refers to the battle the engineers fought within their own branch of the service. In the Civil War, steam ships were vital to the Union blockade strategy, and the proportion of engineers doubled in relation to the line. After the war, slashed budgets and a glut of officers slowed Navy promotions to a crawl. Despite the postwar doldrums, engineers clamored for increased status and rank in relation to the line. Line officers launched a defensive campaign to restrict the rights and privileges of engineers and other staff officers.

Until the end of the century, the line was more successful than the staff at influencing naval legislation. The outcome of the line’s control was that Navy engineers’ professional advancement came to a standstill. Staff officers were left frustrated: without steady promotion through ranks, without the respect of their brother officers in the line, and without the privileges of commissioned officers aboard ship. From the line’s point of

view, 'fighting' becomes a verb: they were fighting against the engineers from the Civil War to the Amalgamation Plan.

The line prevented engineers from measuring career advancement through the traditional military means of promotion in rank. To enhance their status, Navy engineers in the 1880s sought recognition from civilian institutions. The intraservice fight catalyzed Navy engineers to transmit mechanical engineering from Annapolis to American civilian universities and colleges.

The engineers mustered congressional support for a law that detailed them as engineering instructors to colleges and universities. This provided active-duty billets for them in a Navy gutted during postwar retrenchment. Several engineering officers so detailed left the Navy to stay in academia. Other Navy engineers left the service for jobs in industry, eventually directing many of the nation's largest companies. Through these avenues, Navy engineers spread their knowledge across the nation. However, for most of the century neither Navy engineers nor politicians saw the far-reaching consequences of the engineers' struggle for recognition.

Navy engineers developed professional and social networks both within the Navy and in civilian circles. In the process, Navy engineers redefined what it meant to be a naval officer. They left behind the antebellum aristocratic warrior mentality, and presented a new masculine ideal. The new professional naval officer that emerged in the late nineteenth century was a data collector, an analyst, a trained calculator. By the turn of the century, he was also a university-educated "fighting engineer."

Office, 1844), pp. 634-636.
Situating Military Studies Historiographically

The Navy was the nation’s most complex and expensive bureaucracy for much of the nineteenth century, but historians have all but ignored it. For historiographical precedents, one must turn to studies of the Army. Several historical accounts of government technological sponsorship grant agency to officers of that military branch. Forest G. Hill described the role of the General Survey Act and Army civil engineers in national internal improvements.5

Economic historian Alfred Chandler first indicated the link between West Point and modern business management. In his path breaking work, The Visible Hand, Chandler showed that civil engineer George W. Whistler helped develop management and accounting practices to that first modern industry, the railroad. Chandler downplayed the role of the U.S. Army in training Whistler and other early railroad managers.6

A number of scholars, notably historians Keith Hoskin and Richard Macve, noticed the centrality of Army management techniques in that industry. Hoskin and Macve showed that West Point Superintendent Sylvanus Thayer created uniquely American business practices, carried to the nation by U.S. Military Academy graduates such as Herman Haupt.7

The visible hand of military support of technology can be further seen in Merritt Roe Smith’s study of federal armories in the antebellum period. He found that the Army

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Ordnance Department, headed by West Pointer Colonel George Bomford, played a
critical role in nurturing interchangeable parts manufacturing.  

Historians have frequently linked the federal government and Army with
technology development. In each case, Army technology sponsorship was directed
toward a clearly defined goal. In the case of the Army and interchangeable parts
manufacturing, the goal changed through the course of the program. Originally it was to
produce uniform parts for muskets; these parts were not necessarily interchangeable, and
required some hand filing before they could be incorporated into the finished product. As
the project progressed, the goal shifted to interchangeability. By the Civil War, the
technology was sufficiently mature to be carried to government subcontractors, who were
able to replicate the results attained at federal armories. Throughout this Army project,
patrons and technologists moved together toward a goal they mutually defined.

The Navy's nineteenth century contribution to American mechanical engineering
development differs from the Army example. Mechanical engineering in its modern
recognizable form developed in the Navy not because engineers and government patrons
set that goal. Instead, Navy mechanical engineers groped toward professionalization. For
most of the nineteenth century they enjoyed very little support from Washington
politicians. The officers who did find patrons on Capitol Hill were the line officers of the
Navy.

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Government Sponsorship – Army and Navy

The reasons for the focus on the Army are not hard to fathom. Army engineers directed many of the largest and most noticeable civil engineering projects during the antebellum period. The Army’s contributions stemmed from its professional training school, the military academy at West Point, New York. West Point was established in 1802 and closely patterned on a French model, the Ecole Polytechnic. The Military Academy was the country’s initial scientific school and its course of instruction was polytechnic. Army cadets acquired technical knowledge founded on mathematics and the basic sciences. The top students at West Point excelled in civil engineering, and upon graduation the most coveted assignments for young officers were to the Engineers Corps.⁹

As part of the federal government’s program to promote internal improvements, U.S. Army engineers were detailed under the General Survey Act to aid in canal, road, and railroad construction. Army engineer officers surveyed roads for tracks, then served as managers and executives of railroads. They took with them the accounting and managerial practices that were instilled at West Point. In still other cases, Army engineers oversaw the development of new production methods. Ultimately known as “the American system of manufactures,” interchangeable parts manufacturing was another contribution fostered and orchestrated by the Army. These impressive technologies attracted the attention of historians since the 1950s.¹⁰

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⁹ Hill, Roads, Rails, and Waterways, pp. 11, 15-16, 62.
¹⁰ For a discussion of Army engineers’ role in civilian construction projects, see Hill, Roads, Rails, and Waterway. The classic study of Army managerial influence is Chandler, The Visible Hand. Chandler’s work has been superceded in part by that of Hoskin and Macve. For the French roots of interchangeable parts manufacturing, see Ken Alder, Engineering and Revolution: Arms and Enlightenment in France, 1763–1815 (Princeton: Princeton University Press, 1997).
Though granted little notice, Navy programs to foster internal improvements did exist in the antebellum period. A few civilian Navy leaders were cognizant that industrial endeavors sponsored by the Navy could profoundly benefit the nation in ways unrelated to national defense. They preferred their charge to be a flexible, adaptive organization open to new technical experiments. To achieve this goal, the Navy had to develop a stable rubric within which innovation could flourish. Sociologist of science Donald MacKenzie calls this process ‘institutionalization.’ He notes that institutionalization requires the channeling of resources to support the framework and its activities.¹¹ In the antebellum Navy, resources included federal funding for emerging technologies and the administrative will to foster efforts patiently. The first half of this dissertation addresses the process through which the Navy developed that capability.

Secondary Sources

Frank Marion Bennett

At the end of the nineteenth century a glimmer of realization of the Navy engineers’ contribution finally appeared. In 1895 Navy engineer Frank M. Bennett wrote the first history of Navy engineering and engineers. The first edition of The Steam Navy of the United States was followed almost immediately by a second edition. The timing of the book was significant. Navy engineers had just gained a powerful Washington patron, Assistant Secretary of the Navy Theodore Roosevelt. For the first time since the Civil War, engineers gained the upper hand in their battle within the service.

Bennett’s work serves as the basis for almost all naval history touching on Navy engineers and engineering in the nineteenth century. As a historical source it is inescapable, but it must be used carefully. Too many historians have accepted *The Steam Navy* uncritically. Any historian relying on Bennett’s work must realize that he was extremely close to his subject. He graduated from the U.S. Naval Academy’s engineering program in 1878, and personally knew nearly everyone about whom he wrote.

It would have been very difficult for Bennett to write critically about any Navy engineer. He was still on active duty when he wrote the book, and many of the men appearing in its pages were his superior officers. The social world of Navy engineers in the nineteenth century was close-knit; there were only a few hundred engineers in the service. They studied together for four years at Annapolis, where they self-consciously built an esprit de corps. They sailed together as members of a besieged subculture aboard the fleet’s warships. In 1895 active and retired Navy engineers pored over Bennett’s book. It is likely that the author would have been ostracized by them had he been anything but generous in his assessments. As a result, his perspective is heavily biased toward the engineers.\(^{12}\)

I refer to Bennett throughout much of this dissertation, always keeping in mind his position within the Navy and the engineering community. Where Bennett referred to primary sources, I return to those original documents to read them in their entirety to form my own judgment. Invariably when verifying Bennett’s work, I find he was meticulous; his facts can be trusted. Bennett also can be relied upon as a voice for the

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Annapolis-trained engineers: he was self-interested and biased, but all the more valuable because of that perspective.

Some of the most useful information contained in The Steam Navy is the tabular data of the appendices. "Appendix A" is a list of all the engineers that served in the Union Navy during the Civil War. Bennett recorded the date each man joined the fleet, the date of each promotion in rank, and the date each man left the service. Elsewhere, Bennett listed the men billeted to colleges and universities as engineering instructors. These data are very helpful in my attempt to reconstruct careers and assess the impact Navy engineers had on academia.

**Other Secondary Sources**

Another key text and obvious departure point for this dissertation is the work of Monte Calvert, *The Mechanical Engineer in America, 1830-1910*. Calvert published his study in 1967, and he noted the centrality of U.S. Navy engineers to the development of professional mechanical engineering. However, Calvert based most of his analysis of the Navy's contribution on Bennett's work. He did not note the connection between Bennett and the Navy engineers corps. This dissertation builds on Calvert's work and takes it in new directions by using sources untapped by him or Bennett. The early history of Navy engineering through the Civil War sets the stage for the postwar crystallization of mechanical engineering knowledge at Annapolis.\(^\text{13}\)

I refer to three works concerning the United States Naval Academy in my analysis of that institution. Information on the early history of the Academy can be drawn from

\[^{13}\text{Monte Calvert, } The \text{ Mechanical Engineer in America, 1830-1910} \text{ (Baltimore: The Johns Hopkins Press, 1967).}\]
James Russell Soley, *Historical Sketch of the United States Naval Academy*. Soley was an instructor at Annapolis and later became Assistant Secretary of the Navy. His study was published in 1876. Like *The Steam Navy*, it blurs the line between primary and secondary source. Soley also wrote the first biography of Admiral David Dixon Porter. He was biased toward that officer and others of the line; in consequence, little mention of the engineers is made in *Historical Sketch*.\(^{14}\)

A second book is Charles Todorich, *The Spirited Years: A History of the Antebellum Naval Academy*. In the 1970s the author was also an Academy professor, and brings that perspective to the study. It is an entertaining and informative look at Annapolis in its early years, but is light on analysis.\(^{15}\)

The third text important for the cultural examination of Navy officers and Annapolis is Peter Karsten, *The Naval Aristocracy*. Written during the Vietnam War, an anti-militarist tension is evident in the book. Perhaps as a result, Karsten is contradictory in places. The book tends toward oversimplification, with a view of the naval officers corps as uniform in its goals and attitudes. Engineers do not merit a separate index entry in his book, and he devotes only a few pages to the fifty-year controversy between line and staff officers that rocked the Navy in the nineteenth century. A further problem is that Karsten focuses an undue amount of attention on Alfred Thayer Mahan, accepting him as the model for the average naval officer. Mahan was not the norm by any metric. Lastly, Karsten’s chronology is erratic, and he frequently jumps back and forth from the 1840s to

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the 1900s in a single paragraph.\textsuperscript{16} The officers' corps, Annapolis, and the Navy all evolved extensively during that period. Conflating them is a mistake.

**Problems in Naval History**

A word on the general historiography of naval history is in order. Too often the syntheses of naval history do not meet scholarly standards. They may not be submitted to peer review prior to publication, or they may lack footnotes. An example of this type is Kenneth Hagan's *This People's Navy: The Making of American Sea Power*. In lieu of footnotes, the author merely substituted a bibliographic essay. Other synthetic works reiterate the myths of the Navy without ever re-examining primary sources. Many of the naval history textbooks currently used at Annapolis fail to negotiate this pitfall.\textsuperscript{17}

This dissertation seeks to balance a misalignment in naval history. The majority of work in that field traditionally has been biographies of high-ranking officers, biographies of ships, or operational and tactical histories of engagements or campaigns at sea. By adding a nuanced history of technology thread to that fabric, this dissertation follows a new trend in naval history scholarship, joining recently published works by David Mindell, Kurt Hackemer, and William Roberts.\textsuperscript{18}


Historical Agents and Agency

The work that follows is a history of technology, inextricably linked with a cultural history of the Navy. Technical artifacts appear: battleships, the massive triple-expansion and steam turbine engines that powered them, the various gauges and diagrams used by engineers to produce empirical evidence to support their theories. More important than those objects is the engineering knowledge that made them possible.

Mechanical engineering developed into its modern form not because it was destined to do so. There is no predetermined technological trajectory that flows from some primitive state toward perfection. Instead, engineers followed an erratic course toward professionalism, prompted by the line-staff conflict. The engineers in this narrative were not forward-thinking altruistic heroes; rather, they were self-interested men attempting to secure their positions in the Navy. For instance, a lack of billets in the depleted post-Civil War fleet forced Navy engineers to look for employment ashore. They gathered congressional support for a bill similar to the General Survey Act that sent an earlier generation of Army officers into the private sector. Passed into law in 1879, the legislation allowed Navy mechanical engineers to teach at universities for a year or two while remaining on active duty. A few of them taught at American colleges and universities each year thereafter, and some engineers resigned from the Navy to become professors. Within a few decades, a uniquely Navy mechanical engineering pedagogy spread across the United States.
Cast of Characters

This is a story of the federal government, an enormous naval bureaucracy, and faceless corporations. However, these institutions were composed of individuals, and a handful of people within the small corps of Navy officers are critical to the narrative. A very few of them were world famous beyond their years, such as Civil War hero Admiral David Dixon Porter and Arctic exploration hero Admiral George Washington Melville. Melville's influence at the turn of the century alleviated the line-staff problem exacerbated by Porter after the war. Other engineers enjoyed some notoriety in their lifetimes: Ira Hollis, Mortimer Cooley, and William Durand became deans or presidents of universities. And there are the forgotten men, Navy engineers like Asa Mattice, Walter McFarland, and Benjamin Warren who made substantial contributions to industry, engineering practice, and line-staff integration. Finally, some engineers in this story were not known outside of the tight circle of the Navy: Gus Kaemmerling, William Cathcart, Goold Bull. It is clear from reading their papers that these men acted throughout their careers to serve their own interests. They were not pure altruists, seeking to benefit the nation despite any personal cost. These were men like any others in their disposition, faults, and flaws. But they sometimes voiced their desire to serve the commonwealth, and occasionally they glimpsed that their mundane actions would have repercussions beyond their immediate world.

Chapter Summary

Chapter Two – Early Naval Technology Sponsorship
The narrative begins with an examination of the federal government’s response to threat of war with Great Britain in the 1840s. Cabinet-level naval patrons backed generous allocations for experimental ship technologies in order to meet two goals. First, it was hoped that innovations in warships would allow the U.S. Navy to overcome with technological superiority its numerical inferiority *vis a vis* the Royal Navy. Second, the government explicitly stated that the warship projects would help domestic heavy industries grow, weaning the country from dependency on Britain. This was a continuation of the federal interest in internal improvements.

I present two examples to make the point. The first was a unique steam propulsion system designed by a Navy officer, Lt. William Hunter. Several ships were built on Hunter’s plans, and all were notorious failures as warships. One of the two federal objectives was partially served by building the ships: the project spread federal money to several ironworking companies, helping them stay in business through the economic turmoil of the 1840s and 1850s. The Hunter vessels served another purpose. They convinced administrators that the Navy lacked competent engineers among its officer corps.

The second example was a massive iron-hulled, steam-powered, armored warship proposed by a civilian, Robert L. Stevens. The ship was never completed, for a variety of reasons. One was the shortage of an essential ingredient: high quality American iron. Another was a lack of mechanical engineering and materials knowledge. No schools in the nation prepared experts in these fields before the Civil War.
Chapter Three – Professional Training at the Naval School

The Navy built wooden-hulled steam ships alongside these experimental ships, but officers had not been trained to handle steamers. Chapter Three commences in 1845, when Secretary of the Navy George Bancroft established the United States Naval School at Annapolis, Maryland. Steam engineering was part of the school’s curriculum from the first day. However, the rudimentary nature of that early Annapolis technical education spotlights the immaturity of engineering pedagogy in the 1840s. This point is more starkly made by comparisons with the naval educational systems of France and England; neither country had a coherent naval officer training system, though both possessed enormous navies with scores of steam ships.

Professional training for officers wrought important changes for the Navy. It was an element that transformed the institution’s culture. Dominating the Navy before the founding of Annapolis was an aristocratic behavioral model, largely carried by Southern officers. Their rigid behavioral ideal emphasized personal honor, a preoccupation that often led to duels among officers. The duel was not limited to individuals; it was institutionalized in the design of U.S. warships. The American fast frigate was designed to engage enemy vessels one-on-one on the high seas.

Chapter Four – The Mexican War, 1846-48

Juxtaposed between the traditional Navy and a modernizing fleet, the Mexican War conveys the tensions of that evolution. Older officers displayed established aristocratic ideals, while other younger men adapted vessels to new tactics based on scientific skills and steam power. Those junior officers would be the bureau chiefs and
admirals of the next war, and they would carry many of the lessons learned in the Gulf of Mexico to the 1860s.

The practical education officers gained in Mexican waters was noteworthy, and the social linkages made during the conflict were as important. Relationships among the different corps of officers evolved in the decades following the Mexican War, and the roots of some eventual disputes lay in their shared experiences in the 1840s. During wartime in the 1840s, the boundary between line and staff officers blurred. Engineers commanded troops in battle, and stood watches aboard ship as officer of the deck. The engineers fought alongside officers of the line, armed with carbines and rifles. Line officers shared privileges and command authority with the engineers from the outset. In the next war, the line would attempt to stuff that “right to command” genie back into its bottle.

Chapter Five - From Duels to Data

Chapter Five examines the Navy’s contributions to science and technology in the fifteen years preceding the war. This period marks the continuation of an important cultural change for officers, a trend that intensified with the creation of the Naval School at Annapolis in 1845. Officers in the U.S. Navy not only supported the scientific missions of civilians, they planned and executed their own projects as the nation embraced “Manifest Destiny.” Their preparation for these missions was government sponsored. Scores of the Navy’s best junior officers worked in the U.S. Coast Survey, where they picked up mathematical and scientific training. This experience cemented a shift toward increasing scientific literacy in the Navy, and opened new career paths for officers.
Four men who sought scientific careers in the Navy serve as examples. The first officer to make a name through science was Charles Wilkes, leader of the U.S. Exploring Expedition, 1838-42. Perhaps following Wilkes’ lead, Matthew Fontaine Maury collected, analyzed, and displayed oceanographic data in the late 1840s and 1850s.

Technical subjects also warranted scientific inquiry. Ordnance officer John Dahlgren undertook an intensive study of ballistics, made possible by his Coast Survey training. In engineering, Benjamin Isherwood employed scientific methods in his experiments with steam engines and fuels. The results of his experiments had very practical applications in Navy engines rooms after war broke out.

Chapter Six – The Civil War Era: Fighting Engineers

Chapter Six describes some of the changes in the Navy during the Civil War and soon after. The first part of the chapter follows the beginnings of Navy engineers’ battle for expert and professional status. One civilian engine designer in particular, Edward Dickerson, forced the Bureau of Steam Engineering to extend the scientific foundation of engineering. Dickerson and Isherwood, promoted to Bureau Chief, became embroiled in a bitter feud over expertise. Even armed with scientific methods, Navy engineers led by Isherwood could not definitively silence their critics. There was just cause to question the expertise of some Navy engineers. Grievous errors in judgment and calculation in the light draft monitor program squandered millions of dollars. The war showed that the practical skill, theoretical training, and overall education of Navy engineers varied tremendously.
This second part of this chapter shows that the postwar Navy directly responded to the engineering shortcoming made apparent in the war. The United States Naval Academy convened a dedicated engineering program that honed theoretically based education. Annapolis complemented book learning with practical experiences in the machine shop, aboard ship, and at manufacturing establishments. The Annapolis curriculum became a model for technical education in America.

Chapter Seven – The Line-Staff Conflict

After the war, Benjamin Isherwood stepped up his political campaign to increase the status of engineers in the Navy. Chapter Seven explores the internecine rivalry, known at the time as the “line-staff conflict” that arose from Isherwood’s campaign. Opposing him was Vice Admiral David Dixon Porter and a sizable cabal of the Navy’s line officers. They viewed the engineers’ political movement as a threat to their prestige and authority. The collision of line and staff catalyzed the Navy’s rise as the preeminent engineering institution in the nation.

In the 1860s line officers such as Porter held tremendous sway. The line expended significant effort fighting engineers, and Porter discontinued the Annapolis engineering program. By the early 1870s, the outspoken, combative Porter began to self-destruct politically. His enemies in Congress successfully argued that the Admiral had finally overstepped his authority, and the resulting backlash marginalized the war hero. One result of Porter’s downfall was an engineering resurgence at Annapolis.
Chapter Eight – The U.S. Naval Academy, 1871-83

Chapter Eight brings us into the post-war world of Navy engineering. For twelve years, the Annapolis engineering curriculum stood separate from that of the line cadets. Cadet Engineers and commissioned engineering officers consciously constructed a new naval officer ideal in this period. They deliberately presented a different physical appearance from line officers. Civil War veteran line officers wore full, bushy beards. Navy engineers, even those who had served during the war, almost never wore beards. Most of them were clean-shaven or sported only mustaches. This physical distinction was part of engineers’ effort to create an esprit de corps among their small group, first during their shared experiences at the Academy, then aboard ship.

The Navy nurtured a crop of 273 engineering experts between 1871 and 1883, imparting to them theoretical knowledge and practical experience. After four years at Annapolis, these men knew how to design, build, and operate the most complicated machines of their time. They understood the inner workings of their engines in a way their predecessors never could; post-war Navy engineers were steeped in advanced mathematics, materials science, and theories of hydrodynamics and thermodynamics. As a result of the line-staff conflict, this small group of men transferred their knowledge to the wider engineering world. They had a distinct and important multiplier effect on the American economy through the next half century.

Chapter Nine – Navy Engineers in Academia

Chapter Nine examines that multiplier effect in academia. It explains how Navy mechanical engineering knowledge and pedagogy spread across the United States and
became the template for advanced technical education, learning immediately embraced by American industry. Continued political and social friction within the Navy motivated engineers to improve their lot. They formulated several strategies to gain the respect of their brother officers and the general public. They formed professional societies, complete with regularly published journals dedicated to specific branches of engineering.

Most importantly, Navy engineers launched a political campaign to draft educational legislation. In 1879 they lined up congressmen to sponsor a bill, titled "An act to promote the knowledge of steam engineering and iron ship-building among the scientific schools or colleges of America." Under the new law, active-duty engineers were detailed to universities to serve as engineering instructors. By 1894 Navy engineers had shared their knowledge with students at thirty-three institutions in eighteen states. Navy efforts established the mechanical engineering programs at University of Michigan, Johns Hopkins, Ohio State, Pennsylvania State, Vanderbilt, and the Universities of Tennessee and South Carolina. The pedagogy of Navy engineers indelibly influenced American engineering practice.

Chapter Ten – Navy Engineers in Industry

Chapter Ten follows the career tracks of a few Navy men after they left the service and entered industry. Their common experiences at the academy, aboard ship and ashore, and in professional societies created a strong brotherhood. The professional and social networks linking these men mapped onto their paths in the private sector. Navy engineers were in demand as large manufacturing companies took shape. As they filtered into industry, they maintained their connections. Before long, Navy engineers
commanded divisions of leading American corporations. They provided consulting
capacity and machinery to scores of others. The technical knowledge fostered by the
Navy spread throughout American industry in a way not foreseen by the decision makers
of the 1860s.

Chapter Eleven - Conclusions

Taken together, these chapters explore the feedback loops between social conflict
and formation of scientific knowledge in the Navy. As Navy engineers built their
profession after the Civil War, they helped redefine what it meant to be a naval officer.
The officer ideal moved from the aristocratic warrior of the antebellum period to a
college educated, scientifically minded professional at the turn of the century. To
maximize the political utility of their engineering expertise, Navy engineers had to spread
their idea of engineering to a broader audience. They chose to do so in an unprecedented
way, by promoting legislation that allowed them to serve as educators. The government
footed the bill for this foray into academia, and the language of the bill explicitly stated
that it was for the good of the nation. At century’s end, this government-funded
technology, mechanical engineering, served as one of the foundations upon which
America erected the modern industrial economy.
Chapter Two – The Navy and Government Sponsorship of Technology, 1840s

Introduction

In the autumn of 1841 a threat of war shadowed the United States. As in 1776 and 1812, the adversary was again Great Britain; disputes along the Canadian border in Maine and Oregon furrowed brows in Washington and London. Another flashpoint was the courtroom drama playing out in Albany, New York. A Canadian sheriff, Alexander MacLeod, was on trial for his part in the Caroline incident. In late 1837 the crew of the American river boat Caroline actively supported an insurrection by Canadian separatists, ferrying provisions and arms across the Niagara River. During a nighttime attack on the Caroline by loyal Canadians including MacLeod, the vessel was set on fire, cut adrift, and pushed out into the current of the river above the falls. One American died as a result, and the U.S. government protested in the strongest possible terms. In November 1840 MacLeod was arrested in upstate New York. His trial a year later stretched Anglo-American tensions to the breaking point. In New York City rumors circulated of a British fleet staging in Newfoundland, poised to answer a conviction of MacLeod by swooping down on unprotected seaboard cities. New York Governor William Seward was prepared to pardon MacLeod to avoid an international confrontation, and influential newspaper editors consistently downplayed the possibility of war. Nevertheless, the American people felt vulnerable.¹

¹ New York Herald, 8 October 1841, p. 2; New York Herald 12 October 1841, p. 2; Norma Lois Peterson, The Presidencies of William Henry Harrison and John Tyler (Lawrence, KS: University Press of Kansas, 1989), p. 113-114, 116. For the diplomatic correspondence between the U.S. and Britain, see “Secretary of State Daniel Webster to British Minister in the U.S. Henry S. Fox, 24 April 1842,” reprinted in David F. Long, A Documentary History of U.S. Foreign Relations, Volume I: From 1760 to the mid-1890s (Lanham,
There was cause for unease. Many citizens of the Republic remembered the last war with Britain. Twenty-seven years earlier enemy ships commanded the coast, closed ports, and British troops even burned Washington, D.C. In 1841 the United States Navy still could not protect the country from a hostile British squadron. The entire American fleet including auxiliaries consisted of a scant 55 ships scattered around the globe; all but four were powered solely by sail. The European powers were far ahead of America in steam warship construction, with Britain and France adding several new steamers to their fleets every year. Americans still relied on the increasingly limited natural protection offered by the expanse of the Atlantic, though some efforts were underway to modernize the fleet. The nation’s first class war steamer *Mississippi* slid down the ways in Philadelphia during 1841 while her sister, *Missouri*, neared completion at the New York Navy Yard. Newspapers issued public calls to arms for the Navy. From the nation’s commercial center the *New York Herald* warned, “we have our navy alne to depend upon to avert invasion…. Unless our ships are increased in number, or at least unless all are ready for immediate service, on the first outbreak of hostilities our ports would be closed by the enemy’s blockading squadrons....” *Mississippi* would help defend American shores, but one modern ship was not enough to keep the British at bay.

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Technology to Even the Odds

Something had to be done to fend off the enemy should war break out; perhaps new weapons could shorten the odds. Inventors submitted ideas to the Navy, and Congress quickly agreed to fund two proposals for original ship systems. Navy Lieutenant William Hunter fielded the first. His submission was a new form of steam powered paddle wheel, rotating horizontally and fully submerged. Hunter envisioned an entire class of vessels equipped with his machinery fitted to iron hulls. The benefit of this layout was that the propulsive machinery would be protected from enemy gunfire, unlike conventional side wheels. If the arrangement worked, ships equipped with Hunter wheels would have the advantage over their opposition.

The second contract went to a civilian inventor, New Yorker Robert L. Stevens. He and his brother, Edwin, offered to build a floating gun battery to protect their city. Stevens’ battery also would be steam propelled, with “sculls” or propellers of their own design placed safely underwater. The hull would be made entirely of wrought iron, with armor plates laminated four and a half inches thick above the waterline. This hard casing would safeguard the vessel from the shot and shells of any warship then afloat. In theory the invulnerable Stevens Battery could render New York safe from an enemy flotilla.

Hunter’s wheels and the Stevens Battery provide windows on the United States Navy’s antebellum attitudes toward technology and innovation. These inventions were direct answers to the repeated war scares of the 1840s, but they also were part of a

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3 Hunter’s iron ship Union had been authorized during the tensions of 1839, but construction finally commenced in 1841. Two additional Navy ships, Water Witch and Allegheny, were built to Hunter’s design over the next few years. Source: K. Jack Bauer and Stephen S. Roberts, Register of Ships of the U.S. Navy, 1775-1990: Major Combatants (New York: Greenwood Press, 1991), p. 61.

developing trend in the military toward mechanization of war. By 1842 the Navy was willing to fund experiments on a large scale, and entertained proposals from officers within its own corps and from civilians. Voicing the hopes placed in new technology, the Secretary of the Navy in 1843 wrote, "Vessels that can move...against wind and tide, and whose machinery is beneath the reach of an enemy's fire, will be able easily to overcome and destroy any war-vessels of the ordinary structure." The writings of two men who controlled the flow of funds for the projects, Secretaries of the Navy Abel Upshur and George Bancroft, grant a broader historical perspective. They illustrate a well-known facet of American industrial development: throughout U.S. history, the federal government consciously has fostered new industries and technologies.

**Federal Funding for Internal Improvement**

The threat of war convinced Congress to open its purse to fund shipbuilding projects in the 1840s, but the government had another motive for issuing defense contracts. In the late 1830s the Secretary of the Navy sent an officer to visit British shipyards to report on steam warships building there. The U.S. government planned to construct steam warships, too, but refused to import British engines for American vessels. Domestic firms were expected to produce the power plants. This desire for increased American technical competency continued through successive administrations. In the same years as the Stevens brothers prepared to lay down their Battery, John C. Calhoun served in President John Tyler's cabinet. At least since 1819 Calhoun had been a proponent of increasing American commerce through federally sponsored internal improvements. This commitment softened as Calhoun aged, but had not waned entirely in

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5 Report of the Secretary of the Navy 1843, p. 486.
1845. The funds expended by the Tyler administration on new designs and novel materials were seed money for American industry.  

Calhoun was not the only Tyler cabinet member dedicated to building national capabilities. Secretary of the Navy Upshur also explicitly and consistently expressed his desire for Navy building programs to foster domestic industrial development. In his 1841 Annual Report to the President he wrote: “Steamships have been built in Europe altogether of iron.... The great abundance of that material, found in all parts of our country, affords us every facility which can be desired; and our workmen will soon acquire, if they do not now possess, the requisite skill in converting it into vessels. We may thus acquire a cheap and almost an imperishable naval force, while, at the same time, we afford encouragement to some of the most useful branches of our home industry.” He echoed these sentiments in his report the following year: “It is an object of great interest to me to make the navy subservient to the encouragement of American industry.... [I]t is of the utmost importance that we should adopt a policy calculated at once to cherish and to develop these sources of our strength and security.” There was a precedent for this sort of industrial promotion: earlier in the century the Navy funded Paul Revere’s development of copper rolling technology. Naval administrators hoped to enjoy comparable success in production of rolled iron. Even more important than defense, sponsorship of American industry and technology was the chief factor behind

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6 Hill, Roads, Rails, and Waterways, p. 19.
Upshur’s willingness to sponsor the iron-hulled Hunter vessels and the all-iron Stevens Battery project. Incorporating innovative ships built from new materials proved to be a difficult process for the Navy.

**Grappling with New Naval Technology**

In the generations prior to 1840, ship designers and naval architects built wooden sailing vessels that changed very little. For nearly two centuries navies made only slight modifications to existing styles. Major breakthroughs in novel hull materials and propulsive machinery in the 1840s brought new and immediate obstacles. Systemic problems in the Navy hindered the process of introducing new technologies. In America, the Navy grappled with the realization that innovation in ship design could not be accomplished by tapping expert officers – it had none qualified. Until 1841 naval constructors working in government yards usually built vessels for the state; those warships were wooden hulled and propelled by sail alone. Navy constructors had no experience with iron hull construction or steam engine design, and government yards were not outfitted to produce the new forms of ships and equipment. Further, among its officer corps the Navy had no engineers specifically trained to operate the engines of a steamer.

Of necessity naval administrators turned to the civilian sector to find needed engineering expertise and facilities. A private citizen, Charles Copeland, designed the machinery for the war steamers *Mississippi* and *Missouri*. Their wooden hulls were put up in government yards, but two different firms fabricated the engines from Copeland’s drawings: Merrick and Town of Philadelphia, and West Point Foundry in New York.
While the ships were being built, Copeland was offered and accepted a Navy commission as First Assistant Engineer. Other civilian engineers accepted positions in Navy engine rooms, many coming from railroads or engine building shops. Recruiting help from the private sector was a pragmatic solution to the introduction of steam to the Navy, and met with more success than the search for expertise within its officer corps.9

The Navy’s Engineering Deficiency – Hunter Wheels

One attempt to draw on the technical skills of Navy officers was the experiment with propulsive systems designed by Lt. Hunter, inventions often cited among the disasters of navy engineering. They were an example of the early steam Navy’s lack of engineering knowledge, but also point to the Navy’s willingness to experiment on a large scale with new technical systems. The Navy funded three iterations of Hunter-wheel powered vessels: the small 300 ton harbor defense vessel Union, ordered September 1841, delivered January 1843; the iron-hulled Alleghany, ordered 1843, launched 1847; and iron-hulled Water Witch, ordered 1843. Water Witch was built at the Washington Navy Yard and launched in 1845, but refit within a year with a new engine, boilers, and conventional side wheels.

The quick refit of Water Witch was necessary as the Hunter horizontally rotating wheels proved hopelessly inefficient. The wheels had to push water throughout their entire rotation. The force applied to forward motion was partially offset by the force required to push the water in the opposite direction through the arc inside the hull.

9 Charles Stuart, The Naval and Mail Steamers of the United States (New York: Charles B. Norton, 1853), pp. 36, 40; Tomlin, From Sail to Steam, p. 44. The backgrounds of early naval engineers can be ascertained from National Archives Record Group 24 Records of the Bureau of Naval Personnel, Testimonial Letters
Problems arose with the other Hunter vessels, too. After only six months at sea, *Alleghany* docked in Washington in 1849 where she sat for two years. Her Hunter equipment was then removed and replaced with a stern propeller and new engines. *Union* spent fewer than three months actually at sea and after 1848 was used in Philadelphia as a receiving ship for cadets. *Water Witch* was relegated to the scrap heap in 1852. Soon after, a Congressional investigation into expenditures for Navy steam projects revealed that Hunter’s vessels combined cost more than $453,000 to build. After totaling costs for repairs and refits the price tag rose to over $870,000. By comparison, the long-lived

Concerning Engineers, and RG 24 Journals and Report Books of Examining Boards for the Engineer Corps
steamer *Mississippi* and her sister *Missouri* each cost approximately $250,000. Hunter himself benefited financially; in 1847 he received a $10,320 patent fee from the Navy for *Alleghany*. His salary as a lieutenant was only $1500 per year, so this fee was equal to almost seven years of pay. Hunter profited, but the taxpayers did not. In the end, the three expensive Navy vessels fitted with his wheels were declared useless as warships.10

Hunter wheels were placed in the hulls of four other vessels, built for the Treasury Department as revenue cutters. In 1851 Navy Chief Engineer Benjamin Isherwood published a detailed report on the machinery employed in one of them, *Bibb*. Isherwood termed the Hunter-equipped vessels “four miserable abortions.” The diminutive *Bibb* displaced only 409 tons, but cost more than $145,000. Isherwood noted that the ship’s cost approached that of a first-class steam frigate. The engineer complained that “gentlemen whose whole lives have been devoted to the study of law, had better leave questions of engineering to professional engineers.”11

Though the ships did not live up to anyone’s expectations, building them served a larger purpose. Hunter’s four revenue cutters and two of his Navy ships were iron-hulled. Their construction stimulated the domestic iron industry in western Pennsylvania. The contract for the first iron Navy ship, the lake steamer *Michigan*, went to the company of Stackhouse and Tomlinson. Stackhouse soon left the business, and through the 1840s


Joseph Tomlinson won successive contracts for the hull and machinery of other Hunter vessels. By 1850 Tomlinson’s company was considered a very good credit risk. He did a large business and boasted capital worth $20,000. The company continued to prosper through the Civil War, and was worth $60,000 in 1869.  

Federal sponsorship of the iron industry was spread among several companies. Though Tomlinson may have benefited most from Navy and Treasury contracts to build iron ships, other companies also performed government work. In 1845, R.F. Loper built new engines and boilers for Water Witch and lengthened her iron hull thirty feet. In 1851 Abbott and Co. won the contract for the iron plate used in Allegheny’s boiler refit, while the Gosport Foundry provided new hull plates and angle iron for her ribs. This conformed to the spirit of Secretary Upshur’s internal improvement plan to foster American heavy industry.  

Contracts were issued to several firms, but Tomlinson won the largest jobs. Perhaps the Pittsburgh iron worker was favored with a powerful patron on Capitol Hill, a legislator who could influence the granting of government contracts. Some evidence suggests this might have been the case. During the 1840s, Tomlinson and other engine makers and iron working shops in Pittsburgh sent solicitation letters to Representative W.W. Irwin and members of the Navy Commission of the House of Representatives. The congressmen forwarded them on to Commander Lewis Warrington, President of the

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13 Dobbin, “Steam Navy of the United States,” pp. 93, 97-98. The Gosport Foundry referred to in this document was a facility located near the U.S. Navy yard in Norfolk, Virginia. It was not the Gosport Foundry located near the Portsmouth Navy Yard in England.
Board of Navy Commissioners. A patronage relationship between Tomlinson and Irwin cannot be certain, nor can one be established between Tomlinson and Warrington. However, the fact that in the 1840s Tomlinson won government contracts for all of the iron vessels built by private yards suggests that some mechanism other than low bid was at work. Patronage and political connections were critical for antebellum industrialists seeking government contracts.

Civilian Project – Stevens Battery

The process of transforming abstract ideas into functioning war machines in the 1840s was based on patronage and social standing. Hunter operated from within the government system, and was able to find patrons to support his projects. The Navy’s second method of acquiring new technology was to review submissions made by private citizens like the Stevens brothers. The experiences of Robert Stevens underline the value of patronage, and they illustrate the circuitous path inventors followed to bring their projects to fruition.

For civilians interested in acquiring Navy contracts, a necessary initial step was gaining access to high officials in the Navy Department and Congress. Inventors offered ideas to the Navy, sometimes through direct communication with the Secretary, sometimes through political friends who had access to Navy leaders. Robert Stevens was extremely well connected and particularly thorough in his attempts to win a contract. He personally lobbied members of Congress and the Secretary of the Navy. Once these high

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14 See letters from various Pittsburgh concerns to W.W. Irwin, in National Archives Record Group 45, Box 19, Folder (1 of 2) 1842-1847 AC – Michigan, U.S.S., Iron Vessel for patrolling of Great Lakes.
ranking officials granted attention to his proposal, a Naval Review Board had to be convinced that the proposal was sound.\textsuperscript{15}

The Review Board was composed of Navy officers from ordnance and construction, and they faced a thorny task. Expert knowledge was ill defined for budding technologies, including steam engineering and armor manufacture. Since no expert qualifications existed in steam engineering, there was no easy way to identify suitable civilian contractors among those tendering proposals. Compounding this problem, in the 1840s the Navy did not issue rigorous design and performance parameters for technologies it hoped to acquire. Contracts for experimental systems were not open to competitive bidding; the reputation of the submitter figured heavily in the Review Board's approval of schemes under inspection.\textsuperscript{16}

The pitch made by the wealthy, inventive, and influential Robert and Edwin Stevens seemed destined for success. If any men in the country were qualified to undertake such a project, the Stevens brothers were right for the job. Their family had experience in ship construction, building some of the earliest steam powered vessels in America. In armor, too, the Stevens apparently knew their business. Robert had conducted armor tests witnessed by military ordnance specialists earlier in 1841. At close range he fired a series of projectiles weighing up to 64 pounds at a target made of 4½ inch laminated wrought iron plate. The shot and shells could not penetrate the armor.

\textsuperscript{15} See for example, Jason Robinson, “Letter to the Honorable David Henshaw, Secretary of the Navy - Plan of Floating and Other Batteries” (9 January 1844) National Archives Record Group 45 Office of Naval Records and Library Subject File, U.S. Navy, 1175-1910, Box No. 150: BM - Mines and Torpedoes 1810-1892, File: 1844 - Plan of Floating and Other Batteries Submitted. Robert L. Stevens, “Letter to Secretary of the Navy John Y. Mason,” (17 December 1844). Copy held in Stevens Battery Papers, Folder: Correspondence, etc. April 14, 1842 to 1856.

\textsuperscript{16} Examples of contracts issued on the basis of reputation and connection to key figures in the Cabinet and Navy administration are found in the building of the U.S. Navy lake steamer, \textit{Michigan}. See National
This demonstration was absolutely necessary for Stevens’ advancement through the naval review process; it suggested a protected warship was possible.17

Stevens’ idea for the armored Battery was significant. The world had not yet seen an armored warship, though beginning in 1840 European navies embarked on similar armor tests. Jacketed in the proven 4½ inch laminated armor, the Battery would push the envelope of warship technology. Robert Stevens duly presented his plan to the Navy Board of Examiners. That board judged and approved the preliminary Battery proposal, and forwarded it to Secretary of the Navy Abel Upshur. In April 1842 an enthusiastic Congress appropriated $250,000 for the project – a sum equal to nearly 5 percent of the Navy’s total expenditure for the year.18

**Stevens Battery Historiography**

There were good reasons for the government to fund Robert Stevens’ attempt, but ultimately the inventor could not complete the ship. He labored episodically on the Battery until his death in 1856, when sibling Edwin Stevens assumed control of the project. Even in the crises of the 1860s Edwin Stevens failed to concentrate the resources necessary to finish the ship. Despite this, a string of historians since the 1870s has proclaimed the Battery an exemplar of American technological prowess. Nationalistic accounts exalted Stevens’ brainchild as the direct forerunner of Ericsson’s *Monitor* and the modern battleship. Most naval historians writing about the antebellum period make

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passing laudatory reference to the Stevens Battery. Historian Monte Calvert wrote that the Battery “would revolutionize coastal defenses.” Rarely has a historian sought to understand why the Battery never floated. The reasons are many and varied, and they clearly depict the immaturity of naval procurement policies and American industry in the antebellum period.

The most notable examination of the Battery was written by James Baxter in the 1930s. In the space of a few pages in *The Introduction of the Iron Clad Warship*, Baxter outlined the Battery project. He concluded that Robert Stevens failed because he did not know how to build a ship. As evidence, that historian referred to correspondence between Secretary Bancroft and Stevens in 1845. Despite repeated requests from the Secretary, Stevens never submitted construction plan drawings of the vessel. Instead, he sent a written description of the vessel’s dimensions and novel features. The miscommunication between the two men emphasizes the informal nature of engineering at the time. The Secretary of the Navy wanted Stevens to provide engineering drawings, to scale and complete in all details. The inventor believed that his rough description of the ship as he envisioned it should constitute a ‘plan’ sufficient to satisfy the Navy Department. As a result Bancroft suspended all payments in December 1845, refusing to continue funding

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*People’s Navy*, p. 107; Preble, *Complete List*, p. 3; *Annual Report of the Secretary of the Navy 1841*, p. 376.


for a project he felt was dead in the water. Stevens then left for Europe, stating that the stress of dealing with the government broke down his health. 21

Baxter’s assessment of Stevens’ failure lays blame on limited iron shipbuilding knowledge. Examination of the documentary evidence shows that this is not a strong argument. Stevens’ papers show that the Hoboken man planned to develop incrementally the necessary skills for the project, and that he built a dedicated shipyard in which to put up the vessel. It was not lack of skill or lack of planning that prevented the realization of Stevens’ all-iron, armored warship; key negative factors were a faltering of patronage and national industrial immaturity.

Revising History:
Stevens’ Incremental Plan

Iron hull construction was in its infancy in 1842, but some iron ships had been built in the United States. By the mid 1840s the Navy possessed two iron steamers, both built in Pittsburgh. There, Joseph Tomlinson built the hull and engines for the Navy’s small Great Lakes steamer Michigan and Hunter’s slightly larger Alleghany. The contracts worked as envisioned by Upshur, strengthening Tomlinson’s ironworking firm. Robert Stevens had never built an iron ship. To learn techniques, he could have traveled to Pittsburgh to monitor Tomlinson’s efforts. Instead he decided to travel to the world center of iron shipbuilding, Britain. In 1842 he visited several yards there and witnessed first hand the procedures and equipment requisite for putting up large iron hulls. He

21 Baxter, p. 51; Robert L. Stevens, “Memorandum of the Claim of Robert L. Stevens Against the United States” (January 31, 1851); Letter, “Commodore C. Morris to Robert L. Stevens,” (5 December 1845). Copies held in the Stevens Battery Papers, Folder: “Correspondence, etc., April 14, 1842 to 1856.”
returned to America with a clear incremental plan for building the Battery and the will to capitalize the project with his family fortune.\textsuperscript{22}

Stevens first prepared a shipyard for the work. He purchased a plot of land in Hoboken, New Jersey and began to supply it. In addition to a brick shop, large iron punches, machine tools, engines, and hoists, he needed skilled ironworkers to build the ship. It seems that cost was no object. Stevens was willing to spend hefty sums of money to concentrate necessary iron working expertise, believing he would recoup the expenses from the government. He hired experienced ironworkers and paid them high wages. In 1844 boilermakers in his yard earned $2.00 per day, and the more skilled filers and finishers earned $2.25. This was the going wage for iron workers on government service, a rate set in 1841 when mechanical laborers worked on the engines of \textit{Mississippi} and \textit{Missouri}. Joseph Tomlinson paid the same $2.25 wage to the men putting up the iron hulled \textit{Allegheny} in his Pittsburgh yard during 1846 and 1847. The government wage was substantially higher than that paid to men working on private contracts, and it altered the labor market in the iron and shipbuilding industries. In 1844 boilermakers on commercial contracts earned $1.20 at Phoenix Foundry in New York, $1.25 at Novelty Iron Works, and $1.75 at West Point Foundry. Stevens had not yet commenced construction on the Battery, but he paid the higher government rate to his men even when they worked on the yard’s other projects. The good pay of Stevens’ yard attracted talented workers to the Hoboken yard, and the proprietor gave them the opportunity to increase their skills on the job.\textsuperscript{23}

\textsuperscript{22} Letter, “Robert L. Stevens to John Y. Mason,” (1 December 1844), Stevens Battery Papers, Folder: Correspondence, etc. April 14, 1842 to 1856.

\textsuperscript{23} Letters, “Robert L. Stevens to John Y. Mason,” (11 December 1844), and “Stevens to Mason,” (17 December 1844), Stevens Battery Papers, Folder: Correspondence, etc. April 14, 1842 to 1856.
Stevens employed his team on the construction of a small steam boat, designed to
test his scull propeller against conventional paddle wheels. This task quickly
accomplished, the Hoboken yard then built a propeller-driven steam tow boat made
principally of iron for the Camden and Amboy Railroad. After providing his team of
workers this collective iron shipbuilding experience, the Hoboken man tasked them with
the fabrication of an iron-hulled passenger boat of about the same dimensions as the
Battery: 250 feet long, 60 feet wide over the guards. Stevens paid for the most skilled
men he could hire, then in steps increased their knowledge of iron shipbuilding. By early
1845 the Hoboken yard seemed ready to build the Battery. 24

With this range of experience inculcated at the Stevens facility, other obstacles
must have been responsible for hampering the Battery project. Baxter did not delve
deeply enough to see them, and some evidence was unavailable at the time of his study.
Stevens alleviated the immediate problem - the lack of facilities - by spending a portion
of the family fortune on the Hoboken shipyard. However, even the deep pockets of the
Stevens' family had bottoms. 25

In those initial stages of amassing experience in his shipyard, the inventor paid all
of the expenses out of pocket. Some start up expenses likely were recouped from the sale

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24 Tomlinson's wages from "U.S. Navy Department to Joseph Tomlinson, 19 February 1847, Work Ordered
and Finished for Completion Engines Steamer "Alleghany" at Memphis Tenn. as per Agreement with
Alleghany as per Agreement with Lieut. W.W. Hunter Dated Pittsburgh October 10th 1846," National
Archives Record Group 45, Office of Naval Records and Library, Subject File U.S. Navy 1775-1910 AC –
Construction of U.S. Ships, 0-1859, Box No. 21 – Miscellaneous Material 1843-1855 Folder: 1843-1848,
AC – Alleghany, U.S.S. Missouri and Mississippi laborers' wages and other iron works' wages from letter,
"Stevens to Mason," 11 December 1844, National Archives RG 45 Box 20, Folder 2.

25 Letter, "Robert L. Stevens to Thomas Guppy," (23 April 1845), Correspondence Copy Book, Stevens
Battery Papers; A.P. Upshur, "Building of a War Steamer by R.L. Stevens, Letter from the Secretary of the

26 Edwin Stevens' son donated a collection of family papers to the archives of the Stevens Institute of
Technology in 1950, several years after Baxter wrote his analysis of the Battery. Robert Stevens' letters in
that collection make clear the several issues that curtailed the project.
of the tow boat and iron passenger vessel, but other costs were tied only to the
government experiment. Once men and machines stood in the yard, Stevens decided it
would be unsafe to launch the long, heavy Battery by the traditional method of sliding the
hull stern first down a launching ways. Instead he constructed a 330 by 100 foot dry dock
in which to put up and launch the ship. This was a bold move. Dry dock construction was
difficult and expensive. The Navy labored from 1841 through 1846 to complete a dry
dock at the New York Navy Yard, and spent nearly $500,000 in the process. Building the

Figure 2: The Stevens shipyard, Hoboken, circa 1874. The yard represented a large
concentration of capital: buildings, machinery, and wharves could be used for both the Battery
and other projects, but Stevens built a drydock solely to launch the Battery. Unfortunately, no
images of the drydock exist.
Image source: Naval Historical Center, image no. NH91892
Hoboken dock absorbed more than a year of work and tens of thousands of dollars, again out of Stevens’ pocket. Completing a simple but functioning dry dock quickly and comparatively inexpensively was an impressive feat.  

The new fully equipped shipyard absorbed an enormous amount of capital. As early as November 1844, the Navy’s Chief of the Bureau of Construction and Repair realized that costs of completing the Battery would far exceed the original allocation of $250,000. He submitted a special estimate of $340,000 in the budget proposed for 1845, but Congress did not grant the additional funds. Stevens now faced a problem. Under the stipulations of the contract, he could not be reimbursed from the Congressional allocation for any expenses not directly related to the ship. Even if the builder did defray some capital expenses with private contracts, they would not have been sufficient to cover the costs of the dry dock. With bills mounting, Stevens began to petition the Secretary of the Navy for relief. Among other requests, he asked the government in January 1845 to assume the mortgage on the Hoboken property. Events beyond his control then confounded him; administrators sympathetic to his case were about to leave office.

**Patronage**

Patronage was critical to funding the project. Abel Upshur stood behind Stevens at the time the contract was signed, but in the 1840s there seemed to be a revolving door on the office of the Secretary of Navy. Between 1841 and 1853 there were eleven

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Secretaries, resulting in a general lack of vision and continuity at the Navy’s highest level. Not all of the men filling the office cleaved to Upshur’s vision for government sponsored internal improvements. A loss of patronage hindered Stevens. Several secretaries frustrated the Hoboken man by renegotiating the Battery contract. When Upshur switched cabinet seats to become Secretary of State in July 1843, he referred the Stevens contract to Attorney General Legaré. The A.G.’s untimely death soon after caused a delay in action on the contract. No help came from Upshur’s Navy Secretary replacement, David Henshaw. He filled the position for only half a year, and was succeeded by Thomas Gilmer. Gilmer took office on February 19, 1844, but a scant nine days later he and Upshur were both killed in an accident aboard another experimental war steamer, Princeton.²⁸

In a tragedy that mortally underlined the lack of engineering expertise in the Navy, Princeton’s oversized wrought iron gun exploded during a firing demonstration. In addition to the cabinet members, several other bystanders lost their lives in the debacle. The gun was an invention of two men: Swedish inventor John Ericsson, later immortalized by his creation of the ironclad Monitor; and his Navy patron, Commander Robert Stockton. A Board of Inquiry found that the gun likely self-destructed because of irregularities in the material. Nothing could have demonstrated the need for trained engineers and metallurgists more acutely. Ironically, when he was Navy Secretary, Upshur made an argument for research into gun making techniques. He stated: “Too much importance cannot be attached to the soundness of cannon. The bursting of a single gun in battle is often more disastrous than many broadsides from the enemy…. True

²⁷ Report of the Secretary of the Navy 1844, p. 572; Letters, “Stevens to Mason,” (17 December 1844), and “Stevens to Mason,” (11 January 1845).
economy requires that *the very best guns which can be made*, and none others, should ever be used." The death of the forward-thinking Upshur was a blow to the nation, and it eliminated Stevens' strongest supporter in Washington.

Following the disaster, President Tyler appointed John Y. Mason as Navy Secretary. Robert Stevens engaged in lengthy correspondence with Mason, explaining in detail the problems and unforeseen costs encountered in building the experimental vessel. He noted that he had traveled over 6000 miles on trips between Washington and New York, visiting with four or five different secretaries. He also spent seven weeks in Washington during the summer of 1844 discussing the project with the Chief of the Bureau of Construction. Stevens' steady correspondence and persuasion paid off, as Mason agreed to continue the project. The victory was short lived.

Almost as soon as Stevens convinced Mason to sign a new agreement, the Navy Secretary's office door swung again. After President James K. Polk's inauguration, the Hoboken man found himself arguing his case all over again with another Navy Secretary, George Bancroft. This time Stevens failed to win a patron. Bancroft reviewed the work done to date – all preliminary, almost none to the Battery itself – and suspended the project's funding. The frequent changes in naval administration and subsequent loss of patronage were two factors contributing to Stevens' inability to complete the ship, and neither has ever been addressed in scholarly discussions of the Battery.

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28 "Stevens to Mason," (11 December 1844).

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National Industrial Immaturity

Historians have also failed to see the broader industrial landscape in which Stevens worked. Heavy industry in antebellum America was in its infancy, and that immaturity hampered the New Yorker’s efforts to produce his novel warship. The scale of the Battery project was much larger than any iron hull construction in America. The Navy’s 163-foot lake steamer *Michigan* required comparatively little iron, displacing 685 tons. Hunter’s ocean-going *Alleghany* weighed in at 989 tons and measured 185 feet. The 250-foot Stevens Battery dwarfed these ships. In its original layout, it was designed to displace over 4600 tons. Girdled with laminated armor 4½ inches thick, the Battery required far greater quantities of wrought iron plate than any other ship then building worldwide.\(^\text{31}\)

The United States did not possess the industrial infrastructure necessary to complete the Battery in the 1840s. As Stevens equipped his yard and petitioned Secretaries of the Navy between 1842 and 1846, iron production in the nation more than doubled. This was largely in response to the demands of a burgeoning railroad industry. Much of that increased production was absorbed by rails, coming from new rail rolling mills established in Maryland, Pennsylvania, New Jersey, and New England. Data do not exist to estimate the total national output of wrought iron plate in that period. However, data for the iron output of the state of Pennsylvania do exist for the 1840s. Pennsylvania’s rolling mills produced a total of 3,600 tons of boiler and sheet iron in 1842. In 1846 the

\(^\text{31}\) Bauer and Roberts, *Register of Ships*, pp. 39, 61, 82. The Stevens Battery as envisioned in 1842 would displace in excess of 1000 tons more than the mammoth British iron hullled steamer, *Great Britain*, launched 1843.
output of the state’s thirty-two rolling mills increased to 4,400 tons. The 4,600 ton Stevens Battery would have required nearly the entire output of Pennsylvania rolling mills for the year.

Production of American rolled plate iron increased in the antebellum period, answering the demands of the country’s growing industry. By 1860 the nation’s output of rolled boiler plate and sheet iron was 45,000 tons. A great deal of the nation’s prewar output of high quality wrought iron sheet was used to produce boilers for locomotives and river steamers, along with other objects. How little was available for the hull strakes and armor plating of the Battery is suggested by Stevens’ letters to iron producers.

The Hoboken designer’s 1845 memos underline that a lack of American productive capacity in wrought iron plate was a constant problem. Stevens contacted the proprietors of several mills in the United States and Britain, inquiring about their capacity to produce plate and angle iron, the prices for each variety needed, and their ability to machine large iron pieces. He also requested special samples of each mill’s goods, including in his letters rough sketches of pieces he wished to have manufactured. When he found companies willing and able to provide the iron he needed, he arranged contracts. Slowly, stockpiles of material grew at the yard. By the end of 1845 nearly two thousand iron plates sat ready for use in Hoboken. Most of the plates were small, reflecting the


limits of iron rolling technology at the time. The weight of the iron amassed in the yard was under 300 tons, a very small fraction of the total needed for the hull.34

The problem of short supply was compounded by the shoddy quality of many mills’ product. When delivered, iron samples often failed to meet Stevens’ expectations. After examining samples of rivet iron from Richmond’s Tredegar Iron Works, Stevens wrote to the proprietors in frustration. The iron did not pass muster, and was unfit for working into rivets. Unable to use it, Stevens sent it back to Virginia. Even when iron samples proved acceptable, complete plates in subsequent orders frequently were defective. Three days after posting the letter to Tredegar, Stevens’ foreman wrote a terse note to New York iron producer Henry Abbott, one of the country’s largest iron companies. Abbott was tardy in delivering a large shipment of iron boiler plate, and then he only partially filled the order. When the first plates arrived Stevens discovered that several were badly blistered, and two were blistered along their entire length. American iron had a reputation for being of the highest quality, but Stevens’ experience did not bear this out.35 Both Tredegar and Abbott failed to deliver either quality or quantity. Although one of the reasons for building the Battery was to promote American iron production and iron shipbuilding, Stevens was forced to look to another nation’s mills for his plates.

The most telling letters in Stevens’ correspondence copy book are to English concerns. In 1845 he exchanged letters with Thomas Guppy, Mssrs. Gibbs and Bright, and managers of other English firms. Stevens had met all of these men on his preparatory tour of British facilities three years earlier. With Isambard Kingdom Brunel, Guppy was one of the constructors of the world’s largest ship, the iron-hulled screw-propelled Great Britain. Brunel and Guppy were able to build this ship because Britain’s wrought iron production capacity far outstripped any other nation in the early 1840s. Gibbs and Bright was one of the firms that provided iron for the Great Britain. Even that enormous ship required only 1,040 tons of iron in the hull; fully loaded it displaced 3,675 tons.36 The Stevens Battery as envisioned in 1845 would displace 1,000 tons more.

Britain possessed the industrial base to produce a ship like the Battery, and Thomas Guppy suggested that his Bristol works could roll the plates needed and cut them to size. Further, he offered to fit and punch the plates and frames, then ship them to Stevens for final assembly. Stevens declined, stating that as advantageous as that arrangement might be to finishing the project quickly, the Navy Department wanted the ship put up entirely in the United States. The American averred that he was at liberty to procure materials for the ship “where ever I can get it of the best quality and upon favorable terms.”37 Despite the explicit idea that the contracts issued by the government to Stevens and other inventors would promote American industry, Stevens did obtain material from British mills. All of the angle iron and nearly half of the iron plate

purchases recorded in 1845 by the Navy agent in New York originated in British mills.\textsuperscript{38} American firms could not answer the consumption needs of the Battery project.

**Redesign**

A final element beyond Stevens’ control affected his project. Under the stipulations of his contract, he was to provide a ship covered in armor impervious to naval guns commonly in use. Developments at home and abroad in naval ordnance made this a particularly sticky clause. Stevens conducted tests with 4½ inch laminated armor in 1842. He fired both shot and shells weighing 18 to 64 pounds at the armor plates, with a panel of ordnance experts witnessing the demonstration. His plates repelled the projectiles. However, later in the same year another test was performed by the Navy Bureau of Ordnance. This time they tested a new 12 inch wrought iron gun against a laminated wrought iron armor plate “similar in all respects to the one made by Mr. Stevens.” The gun’s enormous 212½ pound shot struck the target in the center, penetrated it, and continued for another five feet into the sand bank behind the target. Stevens knew of this test, and in 1844 asked Secretary Mason for leeway in making the Battery larger. The hull needed extra buoyancy to carry thicker armor plate. Stevens decided to increase the size of the vessel by more than 2000 tons in 1853, as even larger ordnance on naval vessels increased the penetrating power of shot and shells.\textsuperscript{39} The inventor was embroiled

\textsuperscript{38} Bauer and Roberts, *Register of Ships*, p. 39. The production source of only a few hundred plates out of two thousand are listed by the Navy agent. Source: “United States Navy Department Account of War Steamer to Robert L. Stevens, 1 November 1848,” National Archives Record Group 45, Office of Naval Records and Library, Subject File U.S. Navy 1775-1910 AC – Construction of U.S. Ships, 0-1859, Miscellaneous Material 1842, Box No. 20 Folder 4 of 6, 1842-1884 AC – War Steamer, Experimental; Vessel Not Completed.

\textsuperscript{39} “Accident on the Steam-Ship ‘Princeton’,” p. 33; Letter, “Stevens to Mason,” (17 December 1844); Letter, “James C. Dobbin to Robert L. Stevens,” (18 November 1853), Stevens Battery Papers, Folder: Correspondence, etc. April 14, 1842 to 1856; R.T. Merrill, “The Decade of Transisition – Our Early Steam

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in a see-saw contest between ordnance and armor that continued through World War Two.

Stevens’ project limped along. In 1849 the Chief of the Bureau of Construction, Equipment, and Repair wrote a special report to the Navy Secretary. He noted that “the only steps...yet taken for the fulfillment of the contract, are the collection of some material and preparation of the dock in which the vessel is proposed to be built.” By 1854 Stevens reported to the Navy Secretary that he had nearly five hundred men working on the Battery. Progress seemed slow, and few components were complete, however. Stevens averred “the boilers will be ready to put on board in about three weeks,” while other major parts of the machinery were “nearly finished.”

Robert Stevens died in 1856. Charge of the Battery project fell to his brother, Edwin, but little additional progress was made up to the outbreak of the Civil War. In 1861 a Navy board reviewed the Stevens Battery, but came to the conclusion that it would never become an effective warship. It had evolved into a true monster: instead of the original 250 feet, it was now proposed to be nearly 500 feet in length. Then, in 1862, the apparent success of John Ericsson’s Monitor at Hampton Roads sealed the fate of the Hoboken experiment. Congress debated appropriating $750,000 to complete the Battery,

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Navy and Merchant Marine” United States Naval Institute Proceedings Vol. 78 No. 9 (September 1952), p. 1008.
Naval historian Spencer Tucker devoted one paragraph to the Stevens Battery in his discussion of antebellum ordnance, Arming the Fleet. He stated that one of the reasons the Battery was not completed was the increasing power of naval guns. To resist the new guns’ projectiles, armor had to be thicker, so ships had to be larger to accommodate the greater weight of armor (p. 175). Spencer did not comment on any other problems faced by Stevens. Naval historian Robert Love came to the same conclusion; see footnote 17, p. 31.

Figure 3 – Better is the enemy of good enough. Nowhere was this more true than in the evolving Stevens Battery. These images depict its changing appearance from its earliest pre-war concept with seven rotating guns and angled armor plates, to an armored casemate arrangement in 1861, finally to a monitor in 1870. The ship was never completed.

but the performance of the $275,000 Monitor convinced its members that money spent on the Battery would be wasted.\textsuperscript{41}

\section*{Conclusion}

Building a relationship between American industry and the Navy was a goal in the early antebellum period, and it was partly driven by the possibility of war with Great Britain. The most recent historian to examine the early roots of the military-industrial complex, Kurt Hackemer, argued that despite the war scares, a strategic impetus for links between the Navy and industry did not exist in the 1840s and 1850s. He also claimed that “the inherent bias Americans had toward a free-market economy” would have prevented the development of such a relationship, since it would necessarily entail some government interference in the market.\textsuperscript{42}

These assertions may require revision. A strategic impetus to connect industry with the Navy did exist, drawn primarily from the situation with Britain but also from American aspirations for territorial expansion within the hemisphere. Secondly, the U.S. government interfered in the market in a variety of ways, the most obvious of which were the protectionist tariffs enacted by popular demand in the 1840s.

The case of the Stevens Battery shows another area in which the government interfered in the market. By providing higher wages to men in shipyards working on iron-hulled warships, the government deliberately warped the labor market.\textsuperscript{43} Officials were

\textsuperscript{41} Congressional Globe, 27\textsuperscript{th} Congress, 2\textsuperscript{nd} Session (28 March 1862), p. 1394.
\textsuperscript{42} Hackemer, The U.S. Navy and the Origins of the Military-Industrial Complex, p. 5.
\textsuperscript{43} Higher wages were paid to iron workers laboring on government projects. See “U.S. Navy Department to Joseph Tomlinson, 19 February 1847, Work Ordered and Finished for Completion Engines Steamer “Alleghany” at Memphis Tenn. as per Agreement with Lieut. W.W. Hunter,” and U.S. Navy Department to Joseph Tomlinson, “Cut-off Work on Steamer Alleghany as per Agreement with Lieut. W.W. Hunter Dated Pittsburgh October 10\textsuperscript{th} 1846,” National Archives Record Group 45, Office of Naval Records and Library,
not restricted by idealistic beliefs in the free market. They sought pragmatic solutions to the problems facing the nation and Navy, and utilized the argument for internal improvements to smooth the road where possible. Enthusiasm for linking the Navy with programs of internal improvements varied among federal officials. Abel Upshur was one of the strongest proponents. Following his death aboard an experimental war steamer, government sponsorship of industry through Navy contracts waned considerably, but did not disappear.

Experiments with radical naval technology and federal patronage of industry were justified by the recurring threat of war with Great Britain. The possibility of conflict with the world's most powerful navy provided impetus for intellectual ferment and technological innovation, and naval officers and civilians contributed ideas for national defense. A few politically well-connected men were able to formulate and build novel methods of propulsion and protection for steam ships by 1845, with decidedly mixed results. The new experimental designs proved extremely expensive to construct; the few ships that were completed were fraught with problems. Navy review panels considered all of Hunter's experimental warships ineffective. More conventional warships such the wooden sidewheeler Mississippi met with greater success.

As early as 1841, the government recognized that steam propulsion would be a lasting element in warships. Upshur and Bancroft among others saw a clear need for a professional group of commissioned officers trained as naval engineers to design and operate future war steamers. All first generation Navy engineers came directly from civilian life. All of them had been trained in various machine shops and on railroads. A
few of them had formal education in civil engineering at secondary schools or colleges. Upshur recognized that this was not sufficient. His voice joined a growing chorus calling for the formation of a naval academy similar to the military academy at West Point. Naval officers would be educated at the school, and instilling in them basic engineering knowledge would be among the academy's chief goals. With the frustrations of coping with new technology dawned the resolve to lay foundations for future development of officers and machines.\textsuperscript{44}

\textsuperscript{44} Calvert, \textit{Mechanical Engineer}, pp. 19-20; Abel Upshur, \textit{Report of the Secretary of the Navy 1841}, pp. 364-365.
Chapter Three – Naval Culture and the Naval School

Introduction

In 1845 the United States established a Naval School at Annapolis, Maryland to educate its officers. There were two primary factors driving this decision. The first was the Navy’s interest in steam engineering. Naval administrators and several perceptive officers realized that a modern navy required steamers, and that knowledge of steam engines would be essential to officers’ professional training. Formal education of officers would provide the fleet with skilled men able to exploit the new technology.

The second influence leading Navy decision makers to found the Naval School had nothing to do with new technology. Discipline problems wracked the Navy in the 1840s, and it was hoped that a Naval School and a formal admissions policy would remedy some of those ills. One plague on the officers’ corps was the fact that midshipmen obtained their warrants through patronage, not through a competitive process. Influential men could send unruly sons to sea with the Navy. The worst example of this occurred in 1842, an event that moved the desire for a naval school up the Secretary’s agenda. That year, a midshipman on a U.S. warship attempted to foment a mutiny.

Midshipman Philip Spencer served aboard the U.S.S. Somers. He had garnered his appointment through patronage; Spencer was the delinquent son of the Secretary of War. During the cruise of Somers, the midshipman concocted a mutinous plot to murder the brig’s officers, take over the ship, and turn pirate. The scheme was discovered, and the captain of the ship summarily executed Spencer and two conspirators. The incident raised a hue and cry around the nation, and the Navy Secretary’s 1842 report called for
reform. Abel Upshur demanded changes in the training of officers, beginning with midshipmen. Regarding their appointments he stated, "It is a notorious fact, that wayward and incorrigible boys, whom even parental authority cannot control, are often sent to the navy as a mere school of discipline...." Upshur recommended establishing "proper naval schools on shore" to train candidates for naval service.¹ After a few years, the furor over the Somers mutiny subsided, and training in steam engineering reappeared as a leading justification for a naval school.

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Aristocratic Naval Culture:
The Duel Between Men

After supper on the evening of 4 May 1848, a small group of young men walked together to a bowling alley in Annapolis, Maryland. The game about to commence in the twilight of that Thursday had nothing to do with bowling; it was mortal. Secreted from view behind the building, two of the men, Walter Queen and Byrd Stevenson, selected loaded pistols offered by their friends. A few moments later, Queen and Stevenson fired the guns at each other from a distance of ten paces. Queen fell to the ground, a lead ball imbedded deep in his hip.² The immediate reason for the duel was never recorded, but the underlying cause certainly had to do with a perceived insult. The men standing - or now

² Todorich, The Spirited Years, pp. 63-64. Walter Queen was dismissed from service because of this duel, but was reinstated in 1853. He eventually achieved the rank of Rear-Admiral. Lewis Randolph Hamersly, Records of Living Officers of the U.S. Navy and Marine Corps Compied from Official Sources, Fourth Edition (Philadelphia: L.R. Hamersly & Co., 1890), pp. 48-49.
lying - behind the bowling alley cared very deeply about the etiquette of honor. All were midshipmen in the United States Navy.

The behavior exhibited that evening in Annapolis was symptomatic of a situation throughout the Navy in the 1840s. The culture of Navy officers contained problematic aspects, partly based on the service’s demographics. In the early Republic a majority of Navy officers came from New England and the mid-Atlantic states. That changed after the War of 1812 and by 1842, 44% of all midshipmen appointments in the Navy went to young men from the small Virginia-Maryland area of the Old South. One reason for demographic shift might have been the greater economic opportunity for Northern men. Men from that region faced a wider range of job possibilities than their counterparts in the agrarian South. This was particularly so in the lucrative maritime trades. Men with a maritime bent from the Northern states probably found employment in maritime commerce more attractive than a naval career. As the number of officers from that region dwindled after 1815, men of Southern heritage assumed a more prominent role.

Navy officers in the 1840s adhered to a tradition rooted in an aristocratic ideal. By the antebellum period, the aristocratic tradition waned in most areas of the nation. In civil life only the Southern planter class sustained it, but that group exerted powerful cultural influence in the Navy. Antebellum naval administrators were almost exclusively offspring of Dixie. Eight of the eleven secretaries of the antebellum period were from Virginia, Maryland, or North Carolina; another was born in the North but had decidedly

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Southern sympathies. In the antebellum fleet, Southerners brought distinctly aristocratic norms of behavior to the officers' ranks.

The most easily apparent manifestation of aristocratic culture in the Navy was a penchant for dueling to settle perceived insults, a practice that had all but disappeared in the North by 1838. Between 1798 and 1848, thirty-three naval officers were killed in the more than one hundred duels reported; there is no way of telling how many additional encounters were not recorded. Naval historian Charles Paullin noted that before 1815 dueling was "quite common." Stories from the old Navy lend credence to his assertion. In 1802 Lieutenant Richard Somers shot three duels in a day after a group of junior officers questioned his honor and courage. His second in these engagements was Captain Stephen Decatur, youngest man ever promoted to the rank of captain. Decatur himself engaged in at least three duels while an officer, the final contest in 1820 resulting in his demise.

Paullin claimed that the period from 1815 to 1860 saw an increase in duels among naval officers. Navy regulations finally forbade dueling in 1857, but significantly it took until July 1862 – immediately after Southern influence disappeared – for additional regulations to prohibit sending or accepting a challenge, or acting as a second in a duel.\

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Southern cultural domination was one factor contributing to naval officers’ duels, but the Navy’s entire ethos supported the tradition. Navy strategy and tactics were founded on man-to-man duels scaled up to ship-on-ship. The heroic myths of the antebellum Navy embraced engagements of this sort. Examples include the American *Bonhomme Richard* battling the British warship *Serapis* during the Revolutionary War. After sustaining battle damage from the British broadside and ordered to strike his colors, John Paul Jones famously exclaimed “I have not yet begun to fight!” An analogy in a man-to-man duel would be a participant’s insistence on firing a second shot. The dueling tradition continued in the War of 1812. The celebrated combats of the frigate U.S.S. *Constitution* against H.M.S. *Java* and H.M.S. *Guerriere* were ship duels, the latter immortalized by a series of paintings commissioned by Old Ironsides commanding officer, Isaac Hull. A Navy officer in the 1840s would have heard all of these stories, and would have met older officers present during those battles. The expectation to conform to the old cultural and tactical ideal must have been intense, particularly because there was no alternative model of behavior for them to emulate.


Luraghi wrote that only 321 of the 671 Southern officers resigned from the United States Navy to join the Confederacy at the start of the Civil War. Though some 350 Southern officers remained in the Union fleet, their cultural influence was curtailed. See Luraghi, p. 23. Throughout the first half of the nineteenth century, the number of line officers in the Navy was less than 1000, except for the Mexican War years when it rose slightly above that figure (Source: Preble, *Complete List*, p. 23).

For more on the naval engagements of the War of 1812, see Theodore Roosevelt, *The Naval War of 1812* (originally published New York: Putnam, 1882). The engagement of *Constitution* and *Guerriere* including the series of four paintings of the battle are pages 100-109. In these ship engagements, challenges were issued by hoisting ensigns on each vessel; in a man-to-man duel, the challenge would be issued verbally by the one who felt his honor abused, or extended through a second.
The Duel Institutionalized in Ships

The Navy institutionalized the duel in the design of its fighting ships, its tactics, and overall strategy. Exemplified by Constitution, the capital ship of the U.S. Navy was designed specifically for engagements of this type. American frigates were fast-sailing, heavily armed vessels primarily designed to attack commerce. The French termed this commerce-destroying strategy guerre de course; its twentieth century parallel would be Germany’s submarine warfare in World War I. American naval vessels also combated foreign warships; their tactics could be summarized as ‘outgun or outrun’. When a lone enemy was sighted, the American frigate would engage if it matched or outgunned the opponent. If Constitution and her sisters encountered a stronger enemy, they would outrun him. Following the guerre de course strategy, captains of American warships acted alone. Before the Mexican War coordinated fleet actions were rare, and seldom did the Navy combine operations with Army forces. With the duel as their tactical and strategic superstructure, it is not surprising that officers engaged in the behavior on a personal level. Their superiors often overlooked this behavior, since officers were warriors and therefore had official sanction to engage in violence. This indulgence extended to all military officers.  

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The Duel Among Martial Men

Duels in the early republic were not restricted to naval personnel. Army officers also protected their honor with pistols at ten paces, despite the Articles of War expressly prohibiting such actions. In the early national period Army officers participated in forty-three recorded duels, and in twenty-five of those engagements both adversaries were regular officers. During the War of 1812 the Army moved to suppress duels, as the custom threatened military efficiency. Consequently duels involving Army officers

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became increasingly rare; from 1825 until the outbreak of the Civil War only eleven additional duels involved officers. 8

Official approbation was only one factor in the waning of duels among Army officers. In a notable study of professional military officers, historian William Skelton argues convincingly that the decline in duels among this corps is attributable to the fact that after 1820, most officers were West Point graduates. West Pointers "shared a remarkably uniform experience of professional socialization and had emerged with common styles of behavior and a sense of corporate identity." 9 Army officers trained together at their own academy. In contrast, Navy officers did not have a professional training ground. Antebellum Navy officers were unable to form a sense of corporate identity similar to their Army counterparts.

Remedy for Aristocracy – A Naval Academy

The naval reorganization of the 1840s reopened the congressional debate over a school to train professional naval officers. It was not the first time the subject had been broached. Since the nation's birth various legislators periodically introduced bills, and naval administrators and cabinet members also recommended the creation of a naval school. In 1800 as the government contemplated establishing the military academy at West Point, the Secretary of War recommended forming a combined military university. Both army and navy officers would train there, with the naval section employing professors of mathematics, geography, natural philosophy, and drawing. Young naval officers would learn the rudiments of arithmetic, algebra, geometry, statics, and

8 Skelton, An American Profession of Arms, pp. 55-56.
9 Skelton, An American Profession of Arms, pp. 195-196; Paullin, Paullin's History of Naval Administration, p. 193.
navigation before going to sea. This plan was not put into effect. In 1814 President Madison’s Navy Secretary opined to the Senate that a naval academy was necessary to teach mathematics, experimental philosophy, the science of gunnery, naval architectural theory, and mechanical drawing. This suggestion also fell by the wayside. Successive Navy Secretaries continued to beat the drum for the establishment of a naval school, but Congress refused to pass enabling legislation.\textsuperscript{10}

Navy officers also clamored for the formation of a naval school; they routinely passed their opinions to the Navy Secretaries, most of whom already backed the idea. In 1836 fifty-five officers met in the frigate \textit{Constitution} to draft a petition in favor of a naval academy. They insisted that the establishment of a naval school was “the only means of imparting to the officers of the Navy that elementary instruction in scientific knowledge which … has become almost indispensable to the military seaman.” Four years later Lieutenant L.M. Powell, one of the officers who signed the petition aboard Old Ironsides, wrote to the Secretary of the Navy a lengthy plea for a naval school. He outlined a plan to consolidate all of the shipboard instructors and professors at one site ashore. Regarding the naval use of steam, Powell argued that he “could not see the limits to its utility,” and steam engineering knowledge would form “one of the most interesting and useful studies at the proposed Naval school.”\textsuperscript{11}

Why did petitions for a naval school not gain congressional approval? James Russell Soley, a Naval Academy professor in the 1870s and later Assistant Secretary of the Navy, published the most complete early history of the Naval Academy. He explained

\begin{itemize}
\item \textsuperscript{10} Soley, \textit{Historical Sketch}, pp. 11-13.
\end{itemize}
that in the early days of the Republic, many believed that the nation did not require a navy and hoped that it would be abolished. Fear of a standing military force was strong in post-revolutionary America. In addition, legislators representing constituencies away from the coast did not want to spend taxes on a naval force. Representatives and Senators from the South and West repeatedly killed legislation supporting the Navy. That sentiment ebbed as time went on, and by the 1830s a majority in the government understood the need for a professional permanent Navy. As America flexed its expansionist muscle after 1840, an overhaul of the Navy Department was a logical development.¹²

The series of war scares in the early 1840s made it clear to all that the Navy was vital to American economic and strategic interests. Equally clear was the need for naval reorganization. In 1842 Congress passed legislation that created the Bureau system, an attempt to bring order and structure to the department. The Navy was divided into five bureaus: Construction, Equipment, and Repair; Yards and Docks; Ordnance and Hydrography; Provisions and Clothing; and Medicine and Surgery. According to a Congressional report, some of the ills the Bureau system was intended to eradicate included the worthlessness of some vessels and “the excessive waste by continual experiments” in ship design, perhaps references to Hunter’s ships. The author of that report was naval hero Charles Stewart, captain of Constitution during the War of 1812. He was Commodore of the Home Squadron at the time of his report to Congress, in which he wrote, “I cannot find language strong enough to express my conviction of the

¹² Soley, Historical Sketch, p. 13; Woodbury, “Motion to Inquire into the Expediency for Permanent Peace Establishment for Navy” Senate Resolution, 27th Congress, 2d Session (December 15, 1841).
urgent necessity for additional instruction to be imparted to young officers...."\textsuperscript{13} While not advocating a naval version of West Point, he did make a pitch for classes in mathematics, international law, foreign languages, and steam engineering. Stewart thought the best training ground for an officer was a ship at sea, but conceded that another venue might be more appropriate for theoretical education.

Abel Upshur agreed with Stewart, and stressed the importance of science and engineering to the navy officer of the future. In his annual report for 1841, he stated, "The use of steam vessels in war will render necessary a different order of scientific knowledge from that which has heretofore been required... [E]ngineers will form an important class of naval officers...hence it is necessary that they pass through a prescribed course of instruction."\textsuperscript{14} If he had not been killed aboard \textit{Princeton}, Upshur might have been able to found the school he envisioned.

Naval education finally found a place in the reorganization of the 1840s. During his brief stint as Navy Secretary, George Bancroft rearranged the billets of Navy instructors exactly as Lt. Powell had suggested in 1840. Bancroft declared in his Report of 1845, "[T]he ship is not friendly to study;.... Many of the professors were able and willing; but the system was a bad one." Bancroft asked the Secretary of War to transfer Fort Severn at Annapolis to the Navy Department to serve as "modest shelter for the students"; the transfer was effected in early 1845. The choice of Annapolis, a town with a strong Southern heritage, boosted that section's cultural influence on the Navy. Bancroft neatly sidestepped any remaining sectional objections within Congress that could have

\textsuperscript{13} Charles Stewart, "Organization of the Navy," H.R. Doc. No. 111 28\textsuperscript{th} Congress 1\textsuperscript{st} Session February 9, 1844, pp. 2, 12. See also A.P. Upshur, "Reorganization – Navy United States" H.R. Doc. No. 167, 27\textsuperscript{th} Congress, 2d Session (March 31, 1842).

\textsuperscript{14} Report of the Secretary of the Navy 1841, p. 364.
stopped the scheme. The Secretary re-allocated existing funds for midshipmen education, concentrating Navy instructors at Annapolis under the direction and strict discipline of Superintendent Franklin Buchanan.\textsuperscript{15} That choice also bolstered the influence of Dixie in the Navy. Commander Buchanan was a staunch Southerner, later to command the Confederate ironclad \textit{Virginia} in the Battle of Hampton Roads.

**Naval and Technical Education Compared**

The polytechnic course of instruction established at the new Naval School was unlike that offered anywhere else in the Americas. Technical education was available in the United States at few other American institutions. No institution of higher learning specifically prepared engineers to work in steam engineering, and therefore there was no clear path to obtaining expert status in that field. Technical high schools including the Franklin Institute in Philadelphia convened courses in the mechanical arts. The Franklin Institute was founded in 1824, and about the same time similar programs were established in the Northeast. None of them afforded a full course of instruction such as was envisaged at the Naval Academy.

The Franklin Institute emphasized practical work for technically-minded young men. The most successful of its schools taught drawing and drafting, including classes in mechanical, architectural, and landscape drawing. The mathematics school attracted far fewer students, and imparted instruction in algebra, geometry, and surveying and navigation skills. It was abandoned in 1831 after failing to fill seats.\textsuperscript{16} The classes taught


\textsuperscript{16} Bruce Sinclair, \textit{Philadelphia's Philosopher Mechanics: A History of the Franklin Institute 1824-65} (Baltimore: Johns Hopkins University Press, 1974), pp. 121, 129. Little else has been written about the

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at the Philadelphia institute were not complete enough to prepare men for technical careers. They could impart some limited drawing and surveying skills.

The pedagogy of the Naval School was unique in America, and it was similarly exceptional globally. Professional education for line officers was not commonplace in any of Europe’s navies, where officers had almost no formal education in the 1840s. Britain’s Royal Naval possessed the largest and most technically advanced fleet, but its officer training system was all but entirely at-sea apprenticeship. The Royal Navy experimented with a college at its Portsmouth dockyard, but discontinued it in 1837. Before the closing, up to forty students enrolled to learn elementary mathematics and English. After a year at the school, the young men – boys really – spent a probationary period at sea to obtain practical experience. Those found acceptable after a year were promoted to midshipmen, a rank held for six years. The Admiralty re-opened the Portsmouth school in 1839. It was then geared to instruct a few advanced pupils, officers drawn from the higher ranks. In the 1840s there was little or no formal theoretical instruction for junior officers and midshipmen in the Royal Navy, though naval architects did attend a special college. The school for line officers established at Annapolis was a major departure from naval tradition.

particulars of early technical education in the United States. Monte Calvert devoted a single page to the subject in his work, *The Mechanical Engineer in America, 1830-1910* (see pp. 43-44).

Early Discipline Problems

Opening in October 1845, the United States Naval School was supposed to admit new midshipmen, recruited between the ages of thirteen and fifteen. In practice, only seven new midshipmen received appointments. The other slots at Annapolis were filled by a senior class, men who had joined the fleet between 1840 and 1842 and were still waiting for their lieutenants’ commissions. These “oldsters” ranged in age between eighteen and twenty-seven years old, and presented a serious disciplinary problem. Already hardened by years at sea, they frequently resorted to drink and often left school grounds without leave. Even worse, many of the oldsters had no respect for their teachers. In the first years of the School, at least two instructors were hung in effigy from the School’s flagpole. These actions resulted in the dismissal of the plots’ ringleaders, but discipline remained problematic throughout the antebellum period. In 1848 a spate of duels involving midshipmen at the Naval School in Annapolis resulted in severe wounds for two men, one of them Walter Queen. All of the participants including the shooters’ seconds were dismissed from the Navy by order of the President. Annapolis’ second Superintendent, George Upshur, – a Virginian – outlawed duels at the Academy after this, and rule-bound fist fights took their place.\(^\text{18}\)

Academics at Annapolis, 1840s

When the midshipmen were sober, present, and not pointing pistols at one another, they attended classes and practical exercises. Subjects included gunnery and steam, chemistry, natural philosophy, mathematics and navigation, English and French. The men were expected to study from 8:00 a.m. to 10:00 p.m., six days per week. After a

\(^{18}\) Todorich, *The Spirited Years*, pp. 64-65.
year and a half at the School, the midshipmen left Annapolis to extend their practical training at sea. All parties involved in the school’s first year understood that the program would need revision. With an eye toward improvement, an Academic Board accordingly reviewed the embryonic curriculum after the initial year of operation.19

The 1846 Academic Board recommended a method of averaging each midshipman’s grades so performance could be ranked. The merit role was based on raw grades filed weekly and quarterly by each instructor, and the grades were weighted according to three criteria. The first consideration was the professional importance of each branch. Second was the time or ability required to obtain a competent knowledge of the subject. Finally, the Academic Board was aware that certain subjects interested midshipmen more than others: gunnery, for instance, always drew the men’s attention. Midshipmen were inclined to neglect some subjects, one professor observed. The problem was remedied by “giving to them [the neglected subjects] somewhat more weight to ensure a due attention to all the studies.”20 The Academic Board’s suggestions indicate the relative importance of each branch of study for a naval officer.

Mathematics and Navigation were the most important fields of study, each earning a multiplier of 3. Next came Gunnery and Steam, multiplied by 2. Rounding out the formula were French and Natural Philosophy multiplied by 2, English and Chemistry by 1. Navy decision makers deemed familiarity with steam power one of the most important elements of young officers training; two days per week were devoted to

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20 Professor William Chauvenet, “Letter from Academic Board to Commander Franklin Buchanan, Superintendent of the Naval School,” (14 February 1846), National Archives Record Group 405, Records of the U.S. Naval Academy, Entry 25: Book of the Naval School, 1845-46. Record Group held at the Archives of the United States Naval Academy, Annapolis, MD.
instruction in steam and steam engines. French was also critical for scientific training, a tradition borrowed from the West Point Military Academy. West Point cadets learned French. Several notable historians have called attention to Superintendent Sylvanus Thayer’s conviction that France was the “sole repository of military science.”

Midshipmen at the Naval School acquired an education somewhat akin to a modern American high school curriculum. The midshipmen’s youth and lack of preparation precluded study of complex science and mathematics. They had to be drilled in the basics first. Midshipmen studied arithmetic and trigonometry, necessary for navigation. A text on optics served as their introduction to physics, complemented by a physical science volume covering everything from mechanics and acoustics to electricity and galvanism. Their chemistry text was practically oriented, primarily concerned with the production of certain materials such as iron, gunpowder, glass, alum, and ceramics. A lesson book on ordnance and steam engine operation rounded out their technical syllabus. The goal of the Naval School was to produce a corps of young officers familiar with basic science and technology. The emphasis on practical engineering and

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22 The fundamental science texts used at the Naval School included Sir David Brewster, A Treatise on Optics (Philadelphia: Lea and Blanchard, 1845); Karl Peschel, Elements of Physics (London: Longman, Brown, Green, and Longmans, 1845); Denison Olmsted, A Compendium of Natural Philosophy (New Haven: S. Babcock, 1844); a textbook written by the Franklin Institute’s Professor Walter Johnson, The Scientific Class-Book, or, A Familiar Introduction to the Principles of the Physical Sciences (Philadelphia: Key and Biddle, 1835); Johnson’s translation of Friedrich L. Knapp, Chemical Technology: or, Chemistry Applied to the Arts and to Manufactures (Philadelphia: Lea and Blanchard, 1848). Source: Source: RG 405 Records of the U.S. Naval Academy, Entry 25 Box: Book of the Naval School, 1845-46 File: Plan of the Naval School at Fort Severn, Annapolis, MD. Dated August 28, 1846 and approved by George Bancroft. Some of these subjects apparently received cursory attention. For instance, the midshipmen whipped through all 400+ pages of Brewster’s Optics in two weeks. Source: Todorich, The Spirited Years, p. 30.
chemistry and familiarization with production techniques created a tendency toward industrial application of knowledge.

Conclusions

Since the earliest days of the nation, some members of Congress and many naval officers understood the potential value of a naval equivalent to West Point. Congress heard several resolutions in favor of an officers’ school from 1820 through the early 1840s, but a lack of political will and a reluctance to allocate funds bilged the plans. That changed during George Bancroft’s brief tenure as Secretary of the Navy in 1845. Bancroft consolidated education expenses within his department and created the United States Naval Academy at Annapolis, Maryland.

One stated goal of the academy was to build the character and culture of naval officers. Bancroft selected a strict disciplinarian, Franklin Buchanan, as Annapolis’ first superintendent. The Secretary instructed Buchanan to instill in the midshipmen “the principle that a warrant in the navy, far from being an excuse for licentious freedom, is to be held a pledge for subordination, industry, and regularity – for sobriety, and assiduous attention to duty.”\textsuperscript{23} Buchanan could not change the culture of the Navy’s junior officer in his short tenure at Annapolis, but he tried to set a precedent. Duelling among midshipmen was outlawed, and those convicted of dueling were dismissed from the Navy. Discipline at Annapolis grew increasingly more rigorous through the 1840s and 1850s.

A second motivating factor for the establishment of a naval school was officer training in steam engineering. Secretaries Upshur, Henshaw, and Bancroft, along with

\textsuperscript{23} Report of the Secretary of the Navy 1845, pp. 842-843.
several high-ranking officers, wanted to increase the number of steamers in the fleet. They recognized the imperative for officers to increase their familiarization with steam power. Without proper training of officers in command of steamers, the expensive new ships could not meet their full potential. When the school was finally established in 1845, the curriculum was designed to impart basic knowledge in steam engineering. The naval cadets attended classes in natural philosophy (physics and chemistry) and steam engineering.\textsuperscript{24}

Bancroft established the Naval School because of “a great desire to improve the Navy.”\textsuperscript{25} This was primarily a response to the combined shortcomings in discipline and technical knowledge among junior officers. At no time did Bancroft or other naval administrators voice a farther-reaching intent. They did not see the larger possibilities of a scientifically proficient Navy officers’ corps, despite the precedent of the Army officers’ work on national internal improvement projects.

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Before the start of Annapolis’ second academic year, America declared war on Mexico. Officers trained in scientific methods showcased their skills during the 1846-48 conflict, buttressing the belief that such knowledge would improve the Navy. The war also conveys more lessons about the culture of naval officers in the first half of the nineteenth century.


\textsuperscript{25} \textit{Report of the Secretary of the Navy 1845}, p. 647.
Chapter Four – The Mexican War, 1846-48

Introduction

In 1846 the United States entered its first imperialist war overseas. Sidestepping the genocide against the Native American peoples of North America, Ulysses Grant described the Mexican War as “one of the most unjust ever waged by a stronger against a weaker nation.” 1 Though it was unequal, the conflict provided valuable combat experience to young officers. They employed steamers in shallow waters, leveled a blockade, and participated in joint Army-Navy operations. Junior officers of the 1840s became the naval leaders of the Civil War: on the Confederate side Raphael Semmes, captain of the Confederate raider, Alabama; and Josiah Tattnall, later one of the commanders of C.S.S. Virginia. Northern leaders got their first taste of battle in Mexico, as well. David D. Porter, vice admiral in command of the Blockading Squadron in the Civil War, and Union Engineer-in-Chief Benjamin Isherwood both served aboard Spitfire under Tattnall at Vera Cruz. Their exploits in the Civil War show that these men did not forget the strategic, tactical, and logistical lessons they took from the Gulf. 2

One incident of the Mexican War showcased the intersection of tactics made possible by steam technology, the value of scientifically trained officers, and the honor-bound culture of the antebellum Navy. Josiah Tattnall, the first commander of U.S.S.

1 Ulysses S. Grant, Personal Memoirs of U.S. Grant and Selected Letters 1839-1865 (New York: The Library of America, 1990), p. 41. Another veteran put it differently. Famous Confederate raider Raphael Semmes, a Navy lieutenant at the time of the Mexican War, framed American aggression in Mexico as an act of Divine will: “The passage of our race into Texas, New Mexico and California, was but the first step in that great movement southward, which forms a part of our destiny. An all-wise Providence has placed us in juxtaposition with an inferior people, in order, without doubt, that we may sweep over them, and remove them (as a people) and their worn-out institutions from the face of the earth.” Raphael Semmes, Service Afloat and Ashore During the Mexican War (Cincinnati: Wm. H. Moore & Co., Publishers, 1851), p. 67.

2 Soley, Admiral Porter, pp. 67-68; Richard S. West, Jr., The Second Admiral: A Life of David Dixon Porter 1813-1891 (New York: Coward-McCann, Inc., 1937), pp. 46-47. Ulysses Grant was a logistical officer in the Mexican War, and also saw combat.
*Spitfire* performed a daring act during the assault on the port of Vera Cruz. A close reading of Tattnall’s maneuver reveals a great deal about the mentality of naval leaders.

The experiences of two other officers of *Spitfire* in particular merit examination, as they were destined for major roles in the Civil War. Engineer Benjamin Isherwood became Chief of the Bureau of Steam Engineering in the 1860s; in Mexico, he was the senior engineer in U.S.S. *Spitfire*. That ship’s Executive Officer and later captain, David Dixon Porter, became Vice Admiral of the Navy in the Civil War. Events on *Spitfire* in 1847 might have been responsible for the bitter rivalry that ensued between the two officers twenty years later.

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**U.S.S. Spitfire**

In the harbor of Vera Cruz, Mexico in March 1847, Commodore Matthew Calbraith Perry watched one of his commanders in astonishment. Smarting from a slight reprimand from Perry, Commander Josiah Tattnall determinedly maneuvered his small steamer, U.S.S. *Spitfire*, through a narrow channel to a position a few hundred yards from the guns of the island fort protecting the city. From that point, Tattnall shelled the castle. The Mexicans’ return fire had little effect; *Spitfire* was so close the Mexican gunners could not bring their weapons to bear on the Americans easily, and Tattnall kept his steam ship in constant motion. Standing on the deck of his wooden-hulled paddle-wheeled flagship, *Mississippi*, the Commodore repeatedly signaled Tattnall to withdraw.

Tattnall’s action at Vera Cruz passed into the mythology of the U.S. Navy as an example of bravery and willingness to face danger. Beyond noting Tattnall’s personal courage, several observations may be drawn from the event. The first concerns the
culture of nineteenth century naval officers. The legend goes that before the incident, Tattnall had asked Perry where he should position his ship in the coming attack. Perry’s tart answer: “Where you can do the most execution, sir.”

Whether this exchange actually took place is irrelevant; the fact that it exists in Navy mythology hints at the behavioral ideal of antebellum officers. Tattnall and the other line officers commanding the ships and men of the Navy were a proud brotherhood. They were willing to risk their lives to defend their honor, and a perceived slight could send the offended party into harm’s way. Prestige and respect were essential to the Navy officer’s self-worth, and often these were gained through participation in ritualized violence. Tattnall’s decision to place Spitfire within rifle shot of the walls and guns of San Juan de Ulloa must be viewed in the context of the Navy’s southern, honor-bound culture.

Tattnall was a duelist, particularly sensitive to slights against his honor. He had fought in at least one duel as a junior officer, and served as a second in another. If the story of the exchange with Perry is true, then the tone with which the commodore spoke would be all-important. If Tattnall construed the commodore’s comment as condescending, it would have been an insult to the junior man’s honor. Tattnall’s reaction suggests that he was offended. However, he was unable to challenge his superior officer

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to a duel. He instead chose to duel with the fortress. By brazenly putting himself in harm's way, he demonstrated his willingness to risk his life to defend his honor.

Tattnall further defended his honor by returning a snub to Perry. The commodore hoisted signal flags on the flagship's mast, ordering the commander to withdraw. Tattnall refused to acknowledge them. He obeyed the order to withdraw only after an officer in a small boat sallied out nearly an hour later to transmit the command in person. Apparently Tattnall felt that his actions had restored his dignity and safeguarded his reputation, so he followed the order and returned to a safer location. Courage and willingness to face risk and danger were critical components of the code of honor. The few extant written accounts of the Vera Cruz event note that the sailors and officers in the fleet were thrilled with Tattnall's behavior and cheered the vessel as it slid back into formation.⁶

**Beyond Aristocratic Warrior Culture**

*Spitfire* at Vera Cruz illuminated another important aspect of the antebellum Navy: an investment in scientific training for its officers. A critical component of *Spitfire*'s excursion was her ability to make a fast, safe passage up the narrow, unmarked channel. That transit was made possible by the ship's Executive Officer, Lieutenant David Dixon Porter, who surveyed the channel under cover of darkness the night before the assault. The lieutenant knew how to accomplish this task because he possessed extensive experience in hydrographic charting. Like dozens of other junior officers, Porter had been assigned to the United States Coast Survey before the war. The professional utility of that scientific training was evident at Vera Cruz. Overnight Porter collected and analyzed bathymetric data. He presented it to his commander, who then

Figure 5 - An excerpt from a late 19th century chart, depicting Vera Cruz. Note the narrow channel between the city and the Castle of San Juan de Ulloa, site of Josiah Tattnall's legendary assault with Spitfire. Some sources relate that prior to the attack Tattnall's first lieutenant, David Dixon Porter, sounded and charted the channel. These were skills Porter acquired in the Coast Survey before the war.

was able to position *Spitfire* off the fort without striking projecting reefs en route.

Without Porter’s soundings, the mission would have been impossibly risky. The novel tactics displayed at Vera Cruz were a partial return on the Navy’s investment in scientific training for its officers.

The third and least subtle aspect of Tattnell’s dramatic run concerns the impact of new technology on naval tactics and strategy. *Spitfire’s* sudden appearance stunned the Mexican defenders inside the fort. Used to sailing ships, they were unprepared for a warship to navigate the constricted channel and come to point blank range. The vessel was built in the United States for Mexico, originally destined to join the Mexican Navy as a gunboat. The Navy purchased it in 1847 in response to the pressing need for shallow draft steam ships to patrol Mexico’s shoals and rivers, exactly the mission it had been designed to accomplish. The maneuverability offered by steamships allowed tactics that were previously impossible. Commodore Perry had not ordered Tattnell the point-blank position off the castle, and probably never entertained thoughts of it. Steam navigation was new to the U.S. fleet, and senior commanders who had spent entire careers in sailing vessels were not sure how to utilize it best. During the two years of the Mexican War, Navy officers learned.

**Mexican War: Tactical and Technological Training Ground**

In retrospect, the Mexican War was a dress rehearsal for the Civil War. As a junior officer training ground it has not been granted the historical attention it deserves.

The Navy distilled technical, social, logistical, and tactical lessons from the conflict. The

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value of steam warships, already anticipated, was proven in the war. The fleet’s large steamers aided in the blockade of Mexican ports, chasing down sailing vessels filled with contraband just as Union ships would in the Civil War. The waters of the Gulf near Mexico were shallow, however. Navy first-rate steamers like Mississippi were intended for open sea service, and sat too deep in the water to be employed along the shallow Gulf coast or on Mexican rivers. Of the towns along the Mexican coast, only Vera Cruz had water deep enough to allow an ocean-going warship to approach within gun range. The Navy needed shallow draft steam vessels to invest towns protected by reefs and sandbars, and to ease the movement of troops and artillery into the Mexican interior. The Navy purchased five American commercial steamers in 1846 to buttress the Gulf fleet, with another transferred from the War Department. Naval guns mounted on these light draft ships bombarded towns upriver, resulting in the surrender of vital centers such as Alvarado, Tabasco, and Tampico.

The shallow draft steamers allowed new battle tactics and integrated joint Army-Navy operations. Armies had launched amphibious assaults since at least the Trojan War, but never before had invading troops had an easier time landing on beaches. During the invasion of Vera Cruz, thousands of Army troops boarded Navy large sailing vessels and steamboats for transport to the landing zone. The smaller steamers also served as transports, but were more important as tugs for small ‘surfboats’, oar-powered landing craft filled with up to 40 infantrymen. The troops transferred from the larger ships to the surfboats, then trailed behind a steamer situated only a few hundred yards from the beach.

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8 Semmes, Service Afloat, p. 78. Secretary of the Navy John Y. Mason commented in 1846 that at the outbreak of the war with Mexico, there were no suitable vessels for shallow water operations in the U.S. fleet. See Philip Syng Physick Connor, “The Home Squadron Under Commodore Connor in the War with Mexico,” The United Service (November 1896), p. 443.
Shallow draft steamers patrolled close to shore and covered the troops' landing with their guns. At Vera Cruz the landing was unopposed by the Mexicans, who barely had time to react. These new landing tactics made possible by steamer support reduced the deployment time of the troops. According to one account, only ten minutes passed from the time the signal was given to cast off, to U.S. troops standing on shore.\footnote{\textit{Betts, "The United States Navy in the Mexican War,"} p. 52. For details of the capture of Alvarado, see Rear Admiral Caspar F. Goodrich, "'Alvarado Hunter': A Biographical Sketch," \textit{United States Naval Institute Proceedings} Vol. 44 No. 3 (March 1918), pp. 495-514; Bauer, \textit{Surfboats and Horse Marines}, pp. 77-78, 80, 82; Semmes, \textit{Service Afloat}, pp. 89, 91, 127; Soley, \textit{Admiral Porter}, pp. 65-66; Symonds, \textit{Historical Atlas of the U.S. Navy}, p. 68.}

\textbf{Isherwood and Porter}

The Mexican War served as a test bed for new tactics and technologies, but the contribution it made to the professional and social development of officers was as important. The combined operations of army and navy up the rivers and along the coast were a departure from traditional naval engagements. Instead of ship-on-ship battles far out at sea, now naval vessels were part of a tactical and strategic plan that involved several components. Many of the ranking officers from both services and both sides in the Civil War obtained their first combat experience in Mexico.

Thrown together, officers established relationships during the conflict. Two key figures of the 1860s' Navy spent months in very close contact in Mexico. Second Assistant Engineer Benjamin Franklin Isherwood and Lieutenant David Dixon Porter served together in the sidewheel steamer \textit{Spitfire} in 1847.

Isherwood and Porter were similar in some ways. Both were very intelligent and had strong personalities. Isherwood was a gifted engineer, but sometimes let this go to his head. Some contemporaries found that he could be intolerant, even abusive. An insight
into Isherwood's personality can be gleaned from his early publications. Respected Philadelphia engine builder J. Vaughan Merrick criticized one of Isherwood's articles, published in the *Journal of the Franklin Institute*. In a rebuttal published in a later number of the same journal, Isherwood attacked Merrick. The journal's editor noted that he was forced to omit "so much as was necessary to destroy the disagreeable personalities which Mr. I. has been pleased to introduce into the discussion...our journal cannot be made a vehicle for personal abuse."  

Isherwood's career before entering the Navy in 1844 was typical of the fleet's other steam engineers in that he had little formal education. He had attended school in Albany until the age of fourteen, when the Utica and Schenectady Railroad hired him as a draftsman. He published a few articles on various aspects of railroad construction over the next few years, then left the private sector for government employment. He worked for the Treasury Department's Lighthouse Bureau, designing lenses. In 1842 he realized that the Navy's experiments with steam ships would probably result in opportunities for engineers. To gain requisite experience, he found a job with New York's Novelty Iron Works, a manufacturer of marine steam engines. In 1844 he joined the Navy as a First Assistant Engineer, though his rank was reduced one grade during an 1846 reorganization of the engineer corps. Isherwood had six years of engineering shop experience and ten months of sea time in Navy steamers by the time he arrived in Mexico. He sat for his promotion examination aboard the steamer *Mississippi* off Mexico in the summer of 1847, afterwards rejoining *Spitfire* to serve with Tattnall and David Porter.  

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10 Note by the Editor in B.F. Isherwood, "Reply to the Objections of 'M.,'" *Journal of the Franklin Institute* Vol. 50 (December 1850), p. 383.
Like Isherwood, David Dixon Porter was a complex man possessed of extraordinary talents. He also possessed deep personality defects, and his actions throughout his long and varied career make him one of the most intriguing figures in the nineteenth century Navy. He was the son of Commodore David Porter, a hero of the War of 1812. When he was a boy, David Dixon met in his father’s house all of the great heroes of the U.S. Navy: Decatur, Bainbridge, Oliver Hazard Perry. Growing up, the young Porter watched his foster brother, Lieutenant David Glasgow Farragut, and his own older midshipman brother go to sea. Young David’s turn came at the age of ten, when he joined his father for a cruise to suppress piracy in the West Indies. The cruise turned out poorly for the Commodore, who was reprimanded for actions against the Spanish. Commodore Porter was court-martialed and suspended from the Navy for six months, an event that left a deep psychological mark on his son. Disgraced, the commodore left the country with two of his sons, David and Thomas, and accepted a position as General of the Marine of the Republic of Mexico. David Dixon Porter spent seven months in Vera Cruz during this period of his life, playing inside the fortress walls of San Juan de Ulloa. After turning fifteen, he sailed as a midshipman in the Mexican Navy. His career in the Mexican Navy was cut short when his vessel engaged a large Spanish warship off Cuba and was defeated. The young Porter was captured and held as a prisoner of war for several months. Finally, he returned to America and entered the U.S. Navy as a midshipman in 1829.\textsuperscript{12}

David Dixon Porter’s early career in the U.S. fleet was noteworthy. He seemed to be everywhere and know everyone who was important. For nearly six years he was attached to the U.S. Coast Survey, charting the waters around New York City. Coast Survey duty was becoming a path to advancement in the Navy, and many of the brightest young officers passed through it in the 1830s and 1840s. He was promoted to lieutenant in 1841, and saw duty in the elite Mediterranean Squadron aboard the frigate *Congress*. He returned to the U.S. to serve at the Naval Observatory in Washington, working under Lt. Matthew Fontaine Maury to analyze physical oceanographic data. In 1846 the government sent him on a secret mission to Santo Domingo and Haiti. Porter investigated the possibility of the U.S. Navy acquiring a lease of Samaná Bay. Soon after filing his report, the Mexican War erupted. Porter soon had a personal axe to grind against the Mexicans. His younger brother, Theodoric Porter, was killed in Mexico in April 1846 while serving in an Army infantry regiment. Eager to get into the action, David Porter was detailed to the steamer *Spitfire* as First Lieutenant.¹³

Josiah Tattnall commanded *Spitfire*, Benjamin Isherwood was the ship’s ranking engineer, and both he and Porter were aboard when *Spitfire* famously assaulted the fort at Vera Cruz earlier in the year. The actions of those two men allowed Tattnall to perform his audacious act.

*Spitfire: Interaction of Line and Engineer Officers*


While Porter served at the Coast Survey he challenged a fellow officer to a duel over a minor squabble. The men’s friends interceded and cooled tempers, so the duel never took place.
Tattnall left the fleet a few months after this event, and command of *Spitfire* devolved to Porter. In June 1847 the lieutenant took charge while the ship loitered up the Tabasco River. Porter and his ship supported a land campaign against the town of Tabasco, located roughly forty-five miles from the river’s mouth at Frontera.\(^4\)

This was the lieutenant’s first experience as Officer in Charge. Porter quickly proved to the crew that he would brook no nonsense. Two weeks after taking command, the lieutenant charged Ordinary Seaman A. Mitchell with drunkenness. The punishment for this infraction was a dozen lashes with the cat o’ nine tail, the most severe corporal punishment allowed by Navy regulations. On July 12 Seamen Richardson and Holmes felt the lick of the cat: one for insubordination and the other for stealing. Two days later the lieutenant ordered one sailor from *Mississippi* and another from *Potomac* clapped in double irons for misconduct on shore. Porter believed that discipline was essential to an efficient ship, and the crew of *Spitfire* received the message. Under Porter’s command, his crew passed the stifling Mexican summer on the mosquito infested river without further punishments for misconduct.\(^5\)

For several weeks the small ship supported troops on shore. Isherwood and the engineers tended the ship’s power plant, but also served in other roles. Normally officers fulfilled clearly defined duties on Navy ships, but with *Spitfire’s* small complement, the


division between line and staff blurred. At times the warrant and commissioned officers, both line and engineers, left the ship to lead troops in battle. Isherwood personally fought in at least three combat actions, commanding carbiniers and musketeers. In between skirmishes on land and engine room duty afloat, Isherwood and the other engineers often served as *Spitfire*’s officer of the watch. This was a generous act by the engineers and line officers alike. That duty usually was reserved for the line, but in a small ship like *Spitfire* there were too few of them to cover the watch schedule easily. This was particularly true when officers were sick and unable to report for duty, a frequent situation during the war. The engineers’ standing of deck watches gave the line officers a needed respite. In return, by sharing their right to command on the quarterdeck and ashore with skirmishing parties, line officers acknowledged the leadership ability of the engineers.

During the Mexican War Lieutenant Commanding Porter reported favorably on Isherwood’s performance. In 1847 he wrote a warm testimonial letter to support Isherwood’s promotion to First Assistant Engineer, noting that the engineer had provided “very great assistance on duty as a watch officer” in *Spitfire*. However, in the 1860s their relationship was one of open rancor. Porter went so far as to recant his earlier assessment of the engineer, claiming that he removed him from his post for incompetence. *Spitfire*’s deck log provides a record of an event that occurred during one of Isherwood’s deck watches. It might have colored the relationship between Porter and the engineer, possibly laying the foundation for the feud that erupted twenty years later.16

On July 17, 1847 Porter left *Spitfire* with an expedition to capture horses from the Mexicans. While he was ashore, Isherwood was officer of the watch. The engineer directed the ship upriver under steam that night. Shortly after midnight, *Spitfire* grounded on a shallow bank. This was not the first time an American keel touched bottom in the Tabasco River. Groundings commonly occurred as the small steamers navigated Mexico’s shallow, winding, unmarked channels. In this case the crew attempted to back the ship off for the next twelve hours, but *Spitfire* was stuck. The men trained their guns on the road leading to the river, firing grape shot and muskets to drive off bands of attacking Mexican soldiers. At eight in the morning, a boat was sent to Tabasco to notify Porter of the situation. The crew threw up a makeshift stockade on the quarterdeck to protect themselves from enemy musket volleys. A party went ashore to cut green timber for the barrier and to clear chaparral along the river banks. This removed vegetation that otherwise could be used as cover for Mexicans shooting at the ship. Meanwhile, *Spitfire*’s situation temporarily deteriorated as the height of the river dropped a foot.17

Conditions improved on the night of July 19 with rain falling intermittently, and Isherwood noted that the river level began to rise. During the next afternoon the steamer *Scourge* came up river and anchored in the channel near *Spitfire* to provide assistance. The river continued to rise; the ship swung to her anchors, backed off the bar, and fell back down river to Tabasco. Third Assistant Engineer Lafayette Caldwell noted during his evening deck watch that the ship was now leaking, water seeping into the bilge at a

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The honor and legality of Porter’s actions ashore were questionable – Porter intended to steal the private property of unarmed Mexican civilians.
rate of two inches per hour. The pumps could handle that rate of flooding, and the vessel remained on station in support of operations in the area.

*Spitfire* needed to stay close by the town, as Mexican resistance was stiffening. On July 22 *Spitfire* took aboard forty-one Marines wounded during a guerilla attack on Tabasco. The Mexican assault forced the Americans to abandon the city completely, and a withdrawal of personnel began. The ship weighed anchor, ferrying the evacuated Marines to the fleet at Anton Lizaro. Moored off the port, *Spitfire*’s officers noted on the morning of July 26 that the ship was leaking very badly. By that afternoon her crew could not keep up with the inflow. Eighteen men were sent from the sloop-of-war *Decatur* to help keep her afloat. Pumping constantly, the crew worked a sheet of canvas under the hull and partially staunched the flooding. *Spitfire* continued to leak as a result of the grounding in the Tabasco River, but Porter no longer had command. The Secretary of the Navy relieved Porter on July 31, and he returned to the United States.\(^\text{18}\)

*Spitfire* was in worse condition than when Porter took over as Officer in Charge, a point that probably caused him intense dissatisfaction. But did the grounding event on Isherwood’s watch change the lieutenant’s opinion of the engineer? No direct confirmation leaps from his papers, but there was a change in the pattern of Isherwood’s

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\(^{18}\) Deck Log of U.S. Steamer *Spitfire*, 19 July – 1 August 1847. On August 6 Captain Taylor came aboard the ship with his “submarine armour,” apparently a form of underwater breathing apparatus. The ship was drawn into 10 feet of water, and Taylor conducted two inspections. He found that about 15 feet of copper sheathing was torn away from the hull, and a pipe for the Kingston valve (a raw seawater feed) was “bulged in.” This damage occurred during the grounding event of July 18, and was the cause of the leaks.
Figure 6 - Excerpt from a late 19th century nautical chart, depicting the Tabasco River running north from the bottom center of the chart to the Gulf of Mexico (soundings in fathoms). The dotted lines along the river bank indicate that the river's course shifts frequently and therefore is not certain. Tabasco is too far south to appear on this chart, located about 45 miles south of Frontera. Note that the mouth of the river is marked "Entrance changing constantly." The British surveyed the Bay of Campeche north of Frontera in 1844, but it is doubtful that American officers had any charts of the river during the Mexican War. This added to the difficulty of navigating the stream, and the grounding of Spitfire during Isherwood's deck watch in July 1847 was not an isolated incident among American ships up river.

Modern charts put Frontera's position farther west than depicted here, at 18.58 degrees north, 92.65 degrees west. Modern Tabasco is known as Villahermoso, and its position is 17.98 degrees north, 92.92 degrees west.

responsibilities. Porter still allowed his engineers authority to stand deck watches after the incident; the watch officer was effectively in command of the ship during his watch. Third Assistant Engineer Lafayette Caldwell stood at least six watches in the ten days after the grounding. During one period, Caldwell remained officer of the watch for sixteen hours straight. However, from the time Porter came back on the vessel after the grounding until he was relieved of command, Isherwood stood only two and half watches on the deck, far fewer than the norm of previous weeks. Further, the ship was at anchor for Isherwood’s two full watches. When underway, he had the deck only for a short two-hour “dog watch” as the ship steamed back to Frontera following the evacuation of Tabasco.\footnote{Deck Log of U.S. Steamer \textit{Spitfire}, 19 July – 1 August 1847. Dog watches were two half watches of two hours duration, occurring between the hours of 4 and 8 p.m. The purpose was to produce an uneven number of watches in 24 hours. This ensured that watchkeepers would not keep the same watches everyday. The origin of the term is not known, though one source speculates it may have come from the fact that the dog watches were curtailed. See Peter Kemp (ed.), \textit{The Oxford Companion to Ships and the Sea} (Oxford: Oxford University Press, 1976), p. 256.}

Perhaps Isherwood was too busy to stand deck watches, occupied below keeping the machinery running or helping to stem the leak. Possibly additional line officers were among the men evacuated from Tabasco. If so they might have assisted on deck, freeing Isherwood from the task; however, no new officers’ signatures appear in the logbook to indicate this. The positive recommendation Porter submitted for Isherwood during his promotion review suggests that the lieutenant did not hold the engineer personally responsible. However, as events later proved, Porter was a man liable to change his opinion of people on a whim.

Whatever his attitude departing the vessel, Porter was lucky to leave the Mexican coast. An epidemic gripped \textit{Spitfire} immediately after his departure. Lieutenant Charles
Chauncy assumed command from Porter, but was struck down by yellow fever within days. On August 9 nineteen men from *Spitfire* were ashore in the hospital; their Lieutenant Commanding succumbed two days later. The ship had few commissioned officers left: one Acting Master, two Passed Midshipmen, and newly promoted 1st Assistant Engineer Isherwood. There were also two warrant officers: 3rd Assistant Engineers Taggert and Caldwell. With so few officers left, the engineers continued to perform duties usually reserved for the line. For his part, Isherwood started standing deck watches regularly on the day Porter left the ship.\(^{20}\)

Interactions between line and staff officers in the Gulf were significant. It was the first time steamers were used in an American conflict, and the place of the engineer was not yet defined by the Navy. Neither corps demonstrated any dissatisfaction with the other. After David Dixon Porter commanded his first vessel, the steamer *Spitfire*, he wrote a glowing testimonial for Isherwood during the latter's promotion exam.\(^{21}\) Isherwood and other engineers shared the duties of line officers, standing deck watches and commanding troops in patrols and skirmishes. They were fighting engineers. The events of the Mexican War and the relationships that developed between line and staff corps might have set a precedent for harmonious interactions between the two groups.

**Conclusions**

In the late 1840s, America launched an expansionist war against Mexico. Steam warships made their debut in the line of battle along the Gulf coast. They made possible both rapid large amphibious assaults on beaches and armed incursions far up Mexican

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\(^{20}\) Deck Log of U.S. Steamer *Spitfire*, 7 August – 30 September 1847.

\(^{21}\) Later events would show that Porter's opinions of officers changed with the winds, and during the Civil War his recollection of the engineer's performance in Mexico was at odds with his official statement.
rivers. The Mexican conflict was fought largely on land, and the Mexican Navy never
posed a threat to U.S. forces. However, the war affected naval development. Amphibious
assaults on Mexican fortifications and beaches drove home to both Army and Navy
officers valuable logistical, tactical, and strategic lessons concerning steam ships. This
was critical training, for the junior officers of 1846 became the admirals and generals of
the Civil War.

For the first time engineering officers shared the risks and rewards of seaborne
warfare with the Navy’s line officers. Thirty-six engineers served in the fleet off Mexico.
Seven of those engineers stayed in the Navy and rose to powerful positions during the
Civil War, serving as Chief Engineers.22 Benjamin Franklin Isherwood, a Second
Assistant Engineer in 1846, became the Engineer in Chief and Chief of the Bureau of
Steam Engineering in the 1860s. Combat experience in Mexico informed his engine
design decisions in the 1860s.

Line and staff officers set social and professional precedents in 1847. Porter
allowed his engineers to stand watches as Officer of the Deck. The Officer of the Deck
was effectively in command of the ship. By granting executive authority and privileges to
staff officers, Porter acknowledged that engineers were true naval officers. This would
not stand in the Navy of the 1860s, however. The precedents set between line and staff
during the Mexican War gave way to bitterness and internecine dispute in the years
beyond.

22 Bennett, Steam Navy, Appendix A. Two engineers died aboard U.S.S. Mississippi during the Mexican
War, and another four Mexican War veteran engineers passed away before the outbreak of the Civil War.
Chapter Five – From Duels to Data

Introduction

The 1840s and 1850s saw a quickening of scientific endeavor by Navy officers. Three major branches of antebellum science programs included exploration, oceanographic research, and charting efforts. Line officers participated in all of these projects, absorbing a variety of skills in the process. Men assigned to the Naval Observatory and Depot of Charts compiled observations of the physical world, extracted from journals and logbooks of worldwide voyages. They used that information to propose new theories of earth and planetary science, and also to suggest shorter sailing routes between ports. Officers detailed to the United States Coast Survey acquired surveying skills, which required strict attention to detail and precise, repeatable measurements. Every scientific program entailed publication of results in a variety of formats, and very few Navy projects failed to produce these reports. For all officers engaged in these scientific activities, real-world lessons included negotiating the politics and bureaucracy of the Navy and the nation’s capital. Officers’ donning of a scientific cloak over their uniforms in the Navy’s “golden age of science” marked a cultural shift before the war.¹ Antebellum promotion in rank was based entirely on seniority, and with few high positions open progress through junior ranks took decades. The professional model of advancement created by scientific officers strengthened a swing toward meritocracy, thereby serving other Navy men looking to enhance their careers.

The scientific method introduced in surveys and explorations also attracted Navy technologists in the 1850s. They performed controlled experiments with ordnance, steam

¹ Paullin, Paullin’s History, p. 243.
engines, boilers, and fuels. These efforts moved Navy research toward a more scientific footing on the eve of the war, but the transition was incomplete. Failure to preclude incompetent but politically connected inventors like Edward N. Dickerson from winning government engine contracts pointed irrefutably to a lack of expert status among Navy engineers. Additional scientific training among all Navy officers, particularly engineers, was a crucial step in the professionalization of the corps.

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**Naval Officers in Service to Science:**

**Europe**

In the 1800s European countries wrapped oceanic scientific and exploration missions in national flags, each new discovery adding to state glory. By the middle of that century a series of British, French, Russian, and German naval expeditions to the high latitudes and far reaches of the Pacific brought scientists and naval officers to previously unexplored regions. Attempts to engage naval participation in science had deep roots. In 1661 immediately after the organization of Royal Society, its scientists issued a document instructing Royal Navy captains to take a series of oceanographic measurements during their Mediterranean expedition. Response was lackluster, compelling the Royal Society to suggest again in 1666 that sailors collect physical oceanographic data. In the eighteenth century, French and British scientists conducted experiments on the ocean, collected observations, and made discoveries while the naval officers in whose ships they sailed provided transportation and logistical support.²

Enthusiasm among naval officers for these assignments was uneven. Some commanders such as James Cook recognized the significance of obtaining new

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oceanographic knowledge. He and others were willing to support the scientists in their ships and even collected measurements themselves. On the other hand, the indifference to science of less enlightened officers in Britain and France occasionally hampered data collection.  

**American Naval Officers and Science**

American naval officers also caught the nineteenth century wave of scientific interest, but they differed from their European counterparts. Rather than merely supporting civilian scientific missions by collecting data or transporting personnel and equipment, a group of antebellum American naval officers conceived and performed scientific projects on their own, and published the results. The federal government and Navy funded these projects, indicating a clear dedication to science. The Navy justified its involvement easily. One of its primary missions was protection of commerce; applying a broad definition to that duty, the Navy assigned ships and men to the exploration expeditions. In Congress arguments in favor of survey and hydrography were based on promotion of commerce and industry. Easing navigation continued the federal theme of internal improvements.

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Spreading Scientific Method: Coast Survey

The most important antebellum American scientific program was the United States Coast Survey, responsible for producing accurate charts of the nation’s coastline. Reliable charts were a clear boon to commerce, a very real and immediate benefit for the merchant marine. Besides making inshore sailing safer, the Coast Survey had other less tangible benefits. The men trained by Supervisor Ferdinand Hassler learned systematic experimental methods based on physical theory. After Hassler’s death in 1843 his successor, West Point graduate Alexander Dallas Bache, continued in the same vein. Both Superintendents drilled their staff in mathematics and physics. In the 1850s applicants to the survey endured tests in algebra, geometry, plane and spherical geometry, analytical geometry, differential and integral calculus, theoretical astronomy, and analytical mechanics. Coast Survey men learned to apply mathematics to geodesy, and performed triangulations and astronomical observations. Bache’s supporters contrasted this new approach to the traditional surveying method grounded in “common sense” and trial and error formerly practiced in the Navy, perhaps a swipe at Bache’s Navy rival, Depot of Charts Superintendent Lt. Matthew Fontaine Maury.⁵

The Navy lent a hand to the Survey, sometimes by providing ships such as the two schooners detailed in 1850. Navy involvement did not stop with equipment. By law military officers participated in the survey. In 1850, Bache noted in his annual report that the Navy contributed fifty-four lieutenants and passed midshipmen. This level of

involvement increased the next year, with ninety officers assigned to the survey. The 1856 Navy budget included $75,800 for the pay of commissioned and warrant officers attached to the Coast Survey. The annual salary for a lieutenant was still $1500; another fifty officers could have been assigned to the survey that year. With Bache’s dedication to scientific method and mathematical education, a Coast Survey assignment amounted to advanced schooling for Army and Navy officers. The superintendent realized the benefit of this training for Navy officers. He wrote, “the nature of the service [the Navy] and its connexion with the science of the country, are favorable to the development of those qualities in the younger officers which makes them ornaments to their profession.”

Many of the brightest and most ambitious young men in the Navy sought appointment to the Survey, and the list of Navy participants in the project reads like an honor role. An 1890 tally showed that the Navy’s only Admiral, only Vice-Admiral, and sixty percent of Rear-Admirals on the Active or Retired rosters spent time in the Coast Survey early in their careers. Twenty-seven of forty-five active or retired Rear Admirals served on the Coast Survey when they were Passed Midshipmen or Lieutenants. Another twelve Rear Admirals who died before 1890 had Coast Survey experience. The Navy’s best and brightest learned scientific method on the project. The experiences of Navy officers on the Coast Survey contributed to the shift in culture and norms of behavior in their corps. Through the Coast Survey and other scientific projects, Navy officers began to see collection and analysis of data as one of the primary functions of their profession.

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7 Hammersly, Records of Living Officers (Fourth Edition, 1890).
Exploration: Charles Wilkes

Science in the Navy received an enormous boost from the U.S. Exploring Expedition, the earliest American seaborne exploration project. Navy officer Lt. Charles Wilkes commanded the four-year expedition, voyaging around South America to Antarctica, the west coast of the Americas, and the Central Pacific Islands. The field program was completed in 1842 and cost nearly one million dollars. Publication of the results continued through the 1850s, with costs rising over $300,000 by 1856. The project’s scale was much grander than the Lewis and Clark expedition, and generated new knowledge in scientific fields including botany, zoology, meteorology, hydrography, physics, geography, geology, anthropology, and ethnology. With so many disciplines involved in the expedition, naval personnel necessarily partnered with civilian scientists. Civilians contributed to the publication effort but overall control remained with the Navy; Wilkes oversaw the preparation of twenty-four volumes, and wrote eight of them himself.\(^8\)

The Wilkes Expedition provided a model to emulate for other officers. Wilkes received a promotion to commander in July 1843, and then was sent to the Coast Survey.

He was promoted again to captain in 1855.\textsuperscript{9} Participating in scientific assignments could speed a Navy officer along the career path, and the highest levels of the naval administration backed this accelerated advancement for top officers.

In 1845 Navy Secretary Bancroft called attention to the new role science would play in an officer’s career advancement. He railed against the “evils in our navy… the only service where activity and inactivity have fared alike.” Bancroft wanted to see the other officers of the Exploring Expedition promoted. Ignoring Wilkes’ promotion for the sake of his argument, Bancroft wrote that the existing promotion system presented “no opportunities of rewarding those who distinguish themselves by alacrity and capacity.” He complained that of the men who sailed with Wilkes, “not a lieutenant or a midshipman has, in any one instance, received so much as the slightest advancement beyond those who remained… on shore or at easier stations.”\textsuperscript{10} Bancroft might have been exaggerating to make his point. Though not all of the officers of the Wilkes expedition saw immediate advancement, many capable young officers took note of opportunities presented by science.

Through Wilkes’ success, Navy officers began to view as desirable and manly certain kinds of scientific achievement and other non-traditional career paths. For some, science offered the possibility of career advancement and a change from the Southern-dominated mentality of the old Navy.\textsuperscript{11} However, naval culture was not monolithic. Even as new career paths opened, some of the older aristocratic norms permeating the corps persisted. An example of this was a disdain for manual labor or any soiling of hands or

\begin{footnotes}
\item[9] Hamersly, Records of Living Officers (1890), p. 413.
\item[10] Report of the Secretary of the Navy 1845, p. 654.
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Notable Southern officers in the antebellum period included Franklin Buchanan, Raphael Semmes, William W. Hunter, Josiah Tattnall, and Matthew Fontaine Maury.
uniforms outside of battle. For officers cleaving to this older culture, aspects of scientific missions transgressed their professional vision. During the North Pacific Exploring Expedition in 1854, the captain of the flagship *Vincennes* refused to allow the civilian naturalists to bring aboard any sample that “will make any dirt or create the slightest smell.”¹² He felt if science involved grubbing in the mud dredged up from the sea floor, it was to be shunned.

**Oceanography: Matthew Fontaine Maury**

The new scientific career path opening in the Navy was particularly attractive to men barred from the traditional route of advancement, service aboard ship. A few antebellum officers sustained injuries that could have ended their careers or suffered from other physical ailments, but were protected by powerful patrons. Science presented an opportunity for them to stay in the Navy. Lieutenant Matthew Fontaine Maury provides one unique example of an officer who helped define scientific work as an honorable alternative to line duty. Most officers that pursued a science track were from the North, but Maury was decidedly a Southerner. Maury extended the aristocratic ideal in one important way. He construed analysis of scientific data collected during cruises as a gentlemanly intellectual pursuit and a path to a position of authority in the Navy.

The lieutenant was one of the most famous antebellum Navy officers to collect and disseminate scientific knowledge. Born in Virginia in 1806 and raised in Tennessee, Maury was appointed to the Navy as a midshipman in 1825. He sailed for most of the

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next nine years, was promoted to lieutenant, and then spent several years on an extended leave. During that period he wrote his first book, *A New Theoretical and Practical Treatise on Navigation*. Designed as a text for midshipmen, it included lessons in algebra, geometry, trigonometry, and logarithms in addition to navigational theory and exercises. The Navy immediately embraced the lieutenant’s work. After the founding of the Naval School in 1845, Maury’s *Treatise* was a required text for the midshipmen at Annapolis.¹³

Maury’s career took a sudden turn in 1839, when a crippling leg injury sustained in a carriage accident foreclosed his career at sea. Rather than dismissing him from service, Secretary of the Navy Abel Upshur ordered the lieutenant to superintend the Navy Depot of Charts and Instruments.¹⁴ From then until his decision to desert the Navy for the Confederacy twenty years later, Maury applied himself to the emerging field of physical oceanography.

While at the Depot of Charts, he and his staff collected and compiled physical oceanographic data from the logbooks of hundreds of commercial and naval vessels voyaging world-wide. Analyzing the ships’ speeds between positions and the weather and sea conditions along their routes, the Navy officers plotted ocean currents and wind patterns. Maury claimed immediate and universal benefits from the resulting publications, *Explanations and Sailing Direction to Accompany Wind and Current Charts*. He declared that the information contained in the book and appended charts allowed vessels to shave weeks or even months off long voyages, equating to huge


savings in transportation costs. In early editions, he printed an estimate that the wind and current charts saved British commerce an estimated $10 million per year. The Secretary of the Navy proudly repeated this claim in his annual report to the President in 1854.¹⁵

Maury and his supporters trumpeted dramatic reductions in sailing times between ports when helmsmen adhered to his *Sailing Directions*. The directions, however, were not intended to be specific tracks of slavishly followed waypoints. In the 1852 edition of *Sailing Directions*, he explained that if a ship was within 100 or 200 miles of the suggested route, navigators should consider themselves to be on course. The reason for this was the imprecision in Maury’s data. The *Wind and Current Charts* listed monthly averages of wind speed and direction for as many places on the ocean as could be distilled from logbooks. To compute these averages, Maury divided the ocean into sectors measuring fives degrees of latitude and five degrees of longitude on a side. At the equator, each box was therefore 300 nautical miles on a side, or 90,000 square nautical miles. Maury assumed observations of wind speed and direction anywhere within a particular box were constant throughout that box.¹⁶ Any data from the box factored in to the average for that sector. The *Wind and Current Charts* were an attempt to map large more-or-less constant oceanic features: prevailing trade winds and major currents like the Gulf Stream.

Maury’s data was far from perfect, since he only collated information from ships’ tracks. He could not direct them to ply certain routes at certain times of year, leaving gaps

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¹⁶ Matthew Fontaine Maury, *Explanations and Sailing Directions to Accompany the Wind and Current Charts* (Washington, D.C.: C. Alexander, 1852), pp. 33, 270, 283, 306. The *Sailing Directions* also contained data on the positions, numbers, and species of whales caught by whalers, thermal data for the ocean’s surface, color plates of micro and macrofauna, and pictures and descriptions of ocean sampling devices.
in his data set. Maury admitted that the more heavily traveled areas of the sea produced many more observations than sectors off the shipping routes. Some districts' averages were computed from as many as 1800 observations, while other sectors had no data at all for some months. In the 1852 printing the lieutenant noted that successive editions of the directions might contain changes to proposed routes as he amassed more data. The Navy published a new edition annually, and by 1855 the wind charts for the North Atlantic showed hundreds of plotted voyages and the rough limits of the trade winds for all months and seasons. The lieutenant and his staff marked the number of voyages used to distill these limits and averages: sometimes data was drawn from as few as two voyages.\footnote{Maury, \textit{Explanations and Sailing Directions}, 1852 edition, pp. 35. Matthew Fontaine Maury, \textit{Wind and Current Charts} (Washington, D.C., 1855).}

Maury noted a few of the basic assumptions behind the \textit{Sailing Directions}, but he did not eliminate some analytical shortcomings in the text. The lieutenant repeatedly drew comparisons among the "old routes" between ports and the faster "new routes" derived from his wind and current charts. The ship passage data for the old routes predated that of the new routes, often by as much as fifty years. In that half century, major changes in vessel design resulted in speed increases among some types that could have accounted for faster voyages. All of the "new route" ships plied their courses after 1848, and a good many of the fastest voyages were turned in by American clipper ships, vessels designed solely for speed. This alone could have skewed Maury's findings, but other problems emerge in the examples the lieutenant published to support his work.
Figure 7 - An example of Maury's raw data culled from ships' logbooks. This data indicates wind direction and covers four sectors, each five by five degrees of latitude and longitude. Each hatch mark is one datum point. The left axis is wind direction, the right axis is latitude, the top and bottom axes are longitude. Two years' data are entered on this plot, broken down by month (middle row). The number of data points for each month is listed in the diagonal strings of numerals.

Maury published this data sample in all editions of both Physical Geography of the Sea (the source of this image is 1860 edition, plate 5) and Explanations and Sailing Directions to Accompany Wind and Current Charts.
Figure 8 - Another method of displaying data derived from ships' logbooks: Maury's Pilot Chart, indicating wind direction for each month of the year for a given sector. The data display only indicates direction; wind speed is not shown. The circular chart in the upper right is the key for these charts, all for the northern hemisphere. The concentric circles of the charts hold data for the winter months in the outer ring, spring months in the second ring from the outside, summer in the third ring, and autumn in the fourth ring. The inner circle indicates the number of calm days per month. In the charts themselves, the numerals indicate the number of days the wind blew, and the position of the numbers within the circles indicates the wind direction. The data is in effect plotted on a compass rose.

Source: Maury, Explanations and Sailing Directions to Accompany Wind and Current Charts (1852).
In a discussion of voyages to San Francisco indicating the utility of his suggested new route, Maury contrasted recent fast passages. He referred to the nationality of ships arriving in port, noting that American ships equipped with his sailing directions made the shortest passages. True enough, but Maury did not isolate variables that impinged on voyage speeds. For instance, he did not account for the differences in distance traveled by ships originating in America and Europe. He never mentioned the obvious fact that European ships had to cross the Atlantic, whereas American vessels did not. Furthermore, he compared the record-breaking passage of the famous American clipper *Flying Cloud* to English, French and Dutch ships. *Flying Cloud* was capable of sustained speeds in excess of 15 knots; in an earlier portion of the *Sailing Directions*, Maury noted that standard merchant ships sometimes averaged no more than 3 knots. The reader was left to wonder if the difference in passage times to San Francisco among ships of different nations rested in a combination of factors. Was it the use of Maury’s charts by the Americans, or the further distance traveled from European ports? American shipowners had long been infected by the “mania for speed” and with the public placed an exaggerated importance on fast passages.\(^\text{18}\) Speed for speed’s sake was an American fascination. Were European ships in the sample merely dull sailors instead of hard-driven clipper-built designs? On these questions Maury was silent.

In 1855 Maury published the information in *Explanations and Sailing Directions* together with a variety of other information and theoretical speculation in a new form, a popular book titled *The Physical Geography of the Sea*. Though the author and Navy Secretary J.C. Dobbin sang praises of the work, the theories Maury put forth to explain

circulation of ocean currents and atmospheric conditions were not highly regarded by contemporary scientists. In America and Europe, leading scientists dismissed Maury’s publications as amateurish and nearly valueless.\(^{19}\)

An example of contemporary scientists’ opinion of Maury is an 1855 notice of *The Physical Geography of the Sea* that appeared in America’s premier scientific journal, the *American Journal of Science and Arts*. The reviewer listed the chapters of the book, and tersely summed up his opinion in two sentences: “Lieut. Maury in this volume on the ocean brings together under a popular form many of the results and discussions brought out in his Sailing Directions and other publications, and the work cannot fail to find many interested readers. ... While the work contains much instruction, we cannot adopt some of its theories, believing them unsustained by facts.”\(^{20}\) The lack of credit from American scientists might have had something to do with rivalries between Maury’s department and the U.S. Coast Survey. The Survey’s second Supervisor, Alexander Dallas Bache, was a close friend and colleague of the editors of the *American Journal of Science*, and they chose to stand behind Bache in opposition to Maury when writing the short review.

Subsequent authors have pointed out that *The Physical Geography of the Sea* prompted new expeditions and experiments to disprove Maury’s theories; thus, it made an indirect contribution to oceanographic science.\(^{21}\) Despite errors obvious with hindsight, the lieutenant’s writings on physical oceanography were beneficial to the development of the naval vocation. Maury devised new methods of displaying...

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complicated data, starting a trend that was followed by officers in a variety of endeavors. Maury helped solidify scientific inquiry and data analysis as characteristics of the naval officers’ profession.

If contemporary scientists did not find Maury’s work valuable, how was his reputation built and why has it endured? Part of the answer lies in the lieutenant’s position as superintendent of the Naval Observatory and Depot of Charts. That office allowed him to publish tens of thousands of his wind and current charts; more than 50,000 sheets rolled off the presses in 1856 alone. Ultimately the government issued over 210,000 copies of these charts to merchant captains.\textsuperscript{22} With a large printing budget and the authority of his office, Maury was able to build his own myth as a man of science. This was fortified after his death by a biography written by his daughter in 1888, the basis for personal information on the man for all subsequent biographies. Successive biographers have added to the myth, judging Maury’s scientific stature from passages in his own publications and those of his daughter.\textsuperscript{23} It appears that no author or scientist has


Several biographies of Maury exist, none of which are critical assessments of his life and work. The first was written by his daughter, Diana Fontaine Maury Corbin, A Life of Matthew Fontaine Maury (London, 1888), followed by Charles Lee Lewis, Matthew Fontaine Maury, Pathfinder of the Seas (Annapolis: United States Naval Institute, 1927). The only scholarly account is Frances Leigh Williams, Matthew Fontaine Maury, Scientist of the Sea (New Brunswick, NJ: Rutgers University Press, 1963), but her analysis is skewed heavily toward Maury (see Reingold’s 1964 review in Isis, noted above). For popular biographies unencumbered by footnotes and with a distinctly Southern flavor see Jaquelin Ambler Caskie, Life and Letters of Matthew Fontaine Maury (Richmond, VA: Richmond Press, Inc., 1928); John W. Wayland, The Pathfinder of the Seas: The Life of Matthew Fontaine Maury (Richmond, VA: Garrett and
Figure 9 - Maury's 1852 Track Chart of the North Atlantic. By the next edition, the officers working in the Depot of Charts had plotted hundreds of voyages and were beginning to delineate the seasonal fluctuations in the trade winds.

ever critically assessed the practical advantage of his sailing directions, leaving several open questions as to their validity. A new analysis of Maury’s publications would present a truer picture of this particular bit of antebellum Navy science.

**Ordnance: John Dahlgren**

One of the ambitious young Navy officers that choose a scientific career path was Lieutenant John Adolphus Dahlgren. He worked for three years on the Coast Survey under Hassler, and became very friendly with the Superintendent. Like Matthew Fontaine Maury, Dahlgren could have been dismissed from service for physical disability; his eyesight failed. With Hassler’s patronage and influence in Washington, he instead was able to concentrate on a scientific career. While he recovered from eye strain attributed to years on the Survey, the Navy gave Dahlgren leave in Paris. While there he translated into English the work on shells of French ordnance expert Henri Paixhans. Upon his return to America in 1838, Dahlgren applied his mathematical and observational training to the development of his technological specialty, naval ordnance.24

Dahlgren and his crew performed scientific experimentation and mathematical modeling of ballistics, and referred to Army ordnance experiments of pressure curves within the barrels of artillery pieces. These laboriously collected data sets and the training instilled during Dahlgren’s tenure on the Coast Survey resulted in a new system of ordnance for naval vessels, based around the distinctive soda-bottle shaped guns that carried his name. By 1856 the lieutenant was considered among the foremost American

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RANGES OF SHOT
FROM THE
32-Pdr. of 42 cwt.
Mounted on Spar-deck of First class Squared-deck—Rate of
Gun, eight and a third feet above water—Charge 6 lbs.

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Figure 10 — A plan view of one of the gun test ranges surveyed by Dahlgren using skills acquired in the Coast Survey, and an example of the range data collected by the ordnance bureau. Dahlgren recorded the weight and caliber of the shot, the powder charge, elevation of the gun, height above the water's surface, flight time to first impact, number and range of each graze on the water's surface, and number of shots fired to generate the averages.

ordnance experts. In a volume published that year, Shells and Shell Guns, he illustrated again the knowledge and connections gained in the Coast Survey. Dahlgren and the ordnance officers working with him test fired naval guns at a range over the Anacostia River near Washington, D.C. Dahlgren discovered that the initial splash and ricochet splashes of each shot or shell could be plotted using a plane table, equipment he used in surveying. The shores of the river were plotted by triangulation "so as to fix with precision the distances between the Battery and the points that were to constitute the several bases for the Plane-table." The link to his previous assignment was irrefutable. To perform these measurements and observations, he borrowed a theodolite from the Coast
Survey, and specifically thanked Supervisor A.D. Bache for his patronage, imparting his knowledge, and loaning the instruments.  

**Engineering: Benjamin Isherwood**

Technological experimentation was not limited to ordnance. Steam engineering also had its Navy scientific experimenter. Benjamin Franklin Isherwood earned the rank of Chief Engineer at the end of the Mexican War, and soon began a scientific study of applied steam engineering. Isherwood was an inveterate collector of data on engines, boilers, and all things mechanical relating to steamships. Whenever he encountered engineers from European navies, he requested performance data on their ships. During his deployments at sea, he carefully logged a variety of mechanical performance data from U.S. ships. Ashore the engineer studied the data and wrote articles for publication. These articles contained valuable comparative information, and were timely. During the Pierce administration, the Navy started six new steam frigates in 1854. Under President Buchanan another five steamers were built. Isherwood’s work helped Navy committees assess the merits of commercially available engines. The engineer had a complementary goal in mind when writing these pieces. He wanted to set experimental precedents for engineering practice and debunk a host of popular but erroneous contentions.  

Competing theories swirled through the world of steam engineering, and most engineering practice was derived from rule-of-thumb based on anecdotal evidence. Chief Engineer Isherwood decided to collect empirical evidence in order to assess engineering

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theories. In the twelve years separating the Mexican and Civil Wars, Isherwood wrote and published at an incredible rate. The *Journal of the Franklin Institute*, the premier American technical journal of the time, published no less than fifty-five pieces written by the Navy officer. This far outstripped any other author published in that journal. By comparison, fellow Navy Chief Engineers William H. Shock and Charles Haswell published only nine articles each in the same period. Civil engineer Herman Haupt, soon to win fame for his efforts in railroad and bridge construction during the war, published two pieces. In his most energetic writing phase, Superintendent of the Coast Survey Alexander D. Bache published a total of twenty-six articles in that forum and an additional twenty-five articles in the *American Journal of Science*. Isherwood was among the most prolific scientific and technical authors in antebellum America.

The engineer’s writings fell into six categories: two were analyses of the machinery of American and European steam warships. Two more categories were comparisons of steam machinery in American and European commercial ships. Articles in the fifth category concerned steam machinery and boilers in general. Lastly, Isherwood contributed articles on steam theory or experiments he conducted.

The general trend in his writing was from simple to more complex engineering analyses, and from caustic reactions to criticism of his ideas to mature, professional behavior. The engineer’s earliest efforts in 1850-51 were comparisons of radial and

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27 An example of the latter is the belief that adding oatmeal to boilers would prevent scaling and eliminate or reduce the need for “blowing off” steam periodically to remove mineral deposits from the boiler tubes. Isherwood participated in at least two cruises and was stricken with severe dysentery during this period, making his publishing productivity all the more impressive. Sloan, *Isherwood*, pp. 16-18. Publication figures compiled from the Index to the *Journal of the Franklin Institute* for the One Hundred and Twenty Volumes from 1826 to 1885 (Philadelphia: Franklin Institute, 1890) and *American Journal of Science*, 1850-1860. Another prolific American scientist was James D. Dana, one of the publishers of the *American Journal of Science*. That journal published 46 of his articles between 1850-1860. Internationally acknowledged engineer William J.M. Rankine’s work appeared six times in the two journals between 1848 and 1860; in addition to his textbooks, he no doubt published in other journals in Europe.

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perpendicular paddle wheels. Isherwood was working to perfect a feathering paddle float, a system that would allow the paddle segments to enter the water perpendicular to the surface. This was one factor in minimizing the slip of the paddle wheel, a measure of propulsive efficiency. This article raised objections from J. Vaughan Merrick, the son of the Franklin Institute's president, Samuel V. Merrick. The editor of the Journal was forced to omit from Isherwood's rebuttal abusive language. Isherwood also published highly critical remarks on another author's analysis of a screw propeller. The journal editor was forced again to remove "personal and insulting language" from the Navy man's writing. 29

Between 1851-54 he submitted analyses of different engine's performance. Isherwood's primary publication focus was the performance of United States steam warships. In twenty articles written between 1851 and 1855, Isherwood discussed all but one of the Navy's operational steam warships. That vessel, Powhatan, escaped him because it was at sea with Commodore Matthew Perry's expedition to Japan. In a handful of other articles, Isherwood examined Navy steam transports, tenders, and tugs; Coast Survey steamers; and revenue cutters. The Chief Engineer compared these data with

European war steamers and commercial steam vessels. Engineers of French and British war steamers occasionally allowed him to see the steam logs from their ships.\textsuperscript{30}

Isherwood analyzed the actual performance of the engines in Navy vessels. He drew data from the ships’ steam logs, calculating the efficiency of engines, paddlewheels, and propellers. He investigated the speed of U.S. warships, matching the speed estimates from the deck log with the number of piston strokes, and when possible the number of rotations of the propeller shaft. He also took into account the number of sails set, wind direction and force, seas state, and any currents noted in the log.\textsuperscript{31}

In this same four-year period Isherwood wrote about the performance of commercial steamships, particularly the fast American steamers of the Collins line. His civilian engineer colleagues provided the steam logs from those ships were provided by. By studying the logs of American commercial and government vessels, Isherwood knew with certainty the efficiency and speed of his country’s steam ships. Civilian engineers of the Cunard lines granted him free access to their data.

From 1854 through 1857, Isherwood’s writing became increasingly sophisticated and critical. He critiqued the experiments with superheated, or ‘surcharged,’ steam conducted by a civilian engineer. In another 1854 piece, he discussed the experiments made at the Washington Navy Yard with a new form of patent boiler. In each of these


\textsuperscript{31} See, for example, B.F. Isherwood, “Performance of the U.S. Screw Steamship \textit{San Jacinto},” from Norfolk, Va., to Cadiz, Spain, during the month of March, 1852,” \textit{Journal of the Franklin Institute} Vol. 53 (June 1852): 393-397.
articles, Isherwood explored the physical and thermodynamic properties of steam. In 1855, Isherwood published a four-part “Disquisition on the Laws of Laws regulating the Slips of Screw Propellers in Function and Form of Dimensions.” This was based on earlier experiments made by a French steam engineer; Isherwood read widely on topics of steam engineering.

Isherwood’s writings were often aimed at specific targets. He barely masked his disdain for the unsupported claims of inventors and amateur engineering theorists. He sometimes conducted experiments with the goal of “definitively exploding a false theory,” other times to provide a “warning voice” that some inventions were “absolute and unequivocal failures.” In controlled engineering experimentation, dissemination of results, and placing engineering on a scientific footing, Isherwood led the nation’s technical community.

The Chief Engineer’s contributions to the Journal of the Franklin Institute dropped off in 1858, no doubt because he was busy conducting a series of his own experiments. The next year, he published a two-volume book detailing that work. The

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title, *Engineering Precedents for Steam Machinery*, was significant.\(^{34}\) The engineer wished to set the pace for his profession and ground all theory in empirical evidence.

Among the engineer’s first major projects was a comparison of the evaporative efficiencies of different types of coal: anthracite, semi-anthracite, and bituminous. Conventional wisdom in the steam engineering world held that anthracite coal was the best type. It was supposed to provide more heat than the other varieties, with less waste and smoke. Isherwood performed the experiments partly to satisfy his own curiosity, but also because Treverton Coal, a semi-anthracite producer in Pennsylvania, applied to the Navy to have the tests done. Isherwood and fellow Mexican War veteran Chief Engineer J.W. King set up and performed experiments at the New York Navy Yard. Their work showed that of the three varieties of coal, bituminous was the most efficient fuel. It evaporated more water per pound than either of the other types, stowed in a smaller space, and produced less waste. Burning bituminous coal did result in more smoke, and this was a disadvantage for warships as it gave away their position from a greater distance at sea. Isherwood was surprised by the inferior performance of anthracite, which flew in the face of conventional wisdom.\(^{35}\) Not convinced of the results, Isherwood acted as would any good scientist; he repeated the experiments. Replication produced the same findings.

With the disruption of one bit of conventional wisdom already under his belt, Isherwood chose to take on another. Under an accepted theory of the day, Mariotte’s law, engineers expected that steam could be introduced into an engine cylinder at a very high

\(^{34}\) Benjamin Franklin Isherwood, *Engineering Precedents for Steam Machinery; Embracing the Performances of Steamships, Experiments with Propelling Instruments, Condensers, Boilers, Etc; Accompanied by Analysis of the Same*, Vol. II (New York: Bailliere Brothers, 1859).

pressure, and then cut off after the piston had traveled a short way into its stroke. Expansion of the steam would carry the piston through the remainder of the cycle, theoretically furnishing up to a 150% increase in fuel efficiency. Isherwood was not convinced that short cutoff engines lived up to their billing. He wrote that there existed in America a “mania for patent Cut-offs,” with each inventor making absurd claims for increased efficiency when his invention was employed. The Navy engineer decided to expand his experiments to collect data on the efficiency of steam used expansively; none had ever been published before on this subject.\textsuperscript{36}

Isherwood and his fellow engineers pressed the New York Navy Yard Smithery engine into scientific service again. This was the same engine used for the coal experiments. Throughout those earlier tests the engineers employed steam without expansion – that is, they introduced steam into the cylinder through nearly the entire four-foot power stroke of the piston. With this data already collected, the engineers only required a comparative data set to test the efficiency of expansive use of steam. In February and March 1859, the men rigged the mechanical valve on the Smithery engine to cut off the steam 22% into the piston’s stroke. The experiments showed that the theoretical gains from short cutoffs were vastly overstated. Instead of a 150% increase in efficiency, use of steam expansively resulted in a less than 17% increase in efficiency.\textsuperscript{37}

Isherwood’s steam expansion experiments exploring long and short cutoffs laid the foundation for his philosophy of naval steam engines, augmented by his wartime experience in Mexico. The Navy engineer was convinced that “the simplification of

\textsuperscript{36} Isherwood, \textit{Engineering Precedents}, p. vii.
\textsuperscript{37} Isherwood, \textit{Engineering Precedents}, pp. 7, 41, 64.
steam engines...is the first consequence to success and cheapness." He realized that low pressure steam engines were safer and easier to maintain than high pressure engines, and that long piston cut-offs were almost as fuel efficient and more reliable than short cut-offs. Although he did not note it in the text, it is likely that the steam expansion experiments, like the coal experiments, were prompted partly from outside influences. In 1858 just before Isherwood conducted the steam expansion experiments, the Navy signed a contract for a high-expansion engine for the steamer Pensacola. The contractor's name was Edward Dickerson. Dickerson and his theories on steam engineering – particularly his adherence to Mariotte's Law – would plague Isherwood and the Navy for years to come.

Edward Dickerson was a patent lawyer with a keen interest in steam engineering. He had attended school at Princeton but possessed no formal engineering training. His practical knowledge of steam engines stemmed from working on a New Jersey railroad as a young man. In his pursuit of naval contract, any shortcomings in his engineering education or experience were more than offset by his political connections.

Dickerson was the nephew of former Secretary of the Navy Mahlon Dickerson, and knew key figures in Washington, D.C. Most importantly for garnering the 1858 Pensacola contract, he had the ear of two members of the Committee on Naval Affairs, Chairman Stephen Mallory and Senator Yulee of Florida. Dickerson's cohort also included men on the editorial boards of influential newspapers in New York, and financier Paul S. Forbes, who had his own powerful coterie in the capital. The influence over Washington exhibited by Dickerson was impressive. He used his contacts to win the lucrative Navy engine contract over the objections of Navy Secretary Isaac Toucey, Chief

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38 Isherwood, Engineering Precedents, p. viii.
Constructor John Lenthall, and Engineer-in-Chief Daniel Martin. All were reluctant to accept Dickerson’s overly complicated design for a high-expansion engine, but the lawyer’s political connections allowed him to override them.  

Dickerson did deliver the engines for Pensacola in the middle of 1861, more than a year late and far over budget. Finally installed in ship’s hull, the engines were much too large and heavy for the amount of power they developed, were extremely complicated, and prone to breakdowns when run at full boiler pressure. As feared by the Navy’s technical experts, they utterly failed to meet the contract specifications. The engineers running the machinery despised it, and publicly lampooned Dickerson and his lack of expertise. The Navy and its engineers had not heard the last of Edward Dickerson. A

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40 Bennett, Steam Navy, p. 162; Canney, The Old Steam Navy, pp. 68, 69; Sloan, Isherwood, pp. 106-107, 116; Welles, Diary, pp. 489, 505, 507, 519. Welles suspected Senator John P. Hale was also influenced by
lack of professional expert status among Navy engineers was one component in his successful bid to build the engine. Throughout the crisis of 1860s, Navy engineers would fight to achieve that status.

Conclusions

Beginning with the U.S. Exploring Expedition led by Lt. Charles Wilkes, science offered Navy officers a new path to career advancement. The main vehicle for training officers in scientific methods was the Coast Survey. Hassler and Bache imparted skills that extended far beyond surveying. Officers serving on the survey learned to collect and record data carefully, analyze them, and present them in effective ways. Raw data was often tabular, but officers refined it and invented novel formats to convey the information they contained. The charts and plots invented by the Depot of Charts under Maury are examples of this.

For Benjamin Isherwood, scientific method was equally important for career mobility. That engineer saw scientific experimentation as the means to several ends. His overarching goal was to gain professional recognition. He could obtain that through publication of theoretical treatises, or though designing efficient propulsive systems for warships.

To achieve those goals, Isherwood needed an understanding of theoretical aspects of steam engineering based on empirical evidence. He gathered that evidence when he compared the boilers and engines of the world’s commercial and naval steamers in use in the 1840s and 1850s. He contrasted the propulsive efficiency of different forms of paddle

Dickerson. Hale admitted that he accepted money from private concerns, but termed this money a "fee," not a bribe. Gideon Welles described the Senator as "a mass of corruption."
wheels and screw propellers. Finally, he devised and conducted original experiments in thermodynamics. Isherwood was the best-educated engineer in America by the outbreak of the Civil War, perhaps the first true mechanical engineering expert in the nation.

Isherwood could lay claim to engineering expertise in the mid-nineteenth century based on his performance, but others touted their expertise without a scientific background. Edward Dickerson won the Pensacola engine contract despite the opposition of Engineer-in-Chief Martin. Historian Lance Buhl pointed out that mid-century naval engineers’ technical opinions carried no more weight than the opinion of nonprofessionals. Based on the evidence of Dickerson’s engine contracts, he argued, “anyone remotely familiar with the steam engine could pass as an expert.”41 The scientific method Chief Engineer Isherwood was beginning to employ had not yet taken hold in the engineering world. Technical arguments of dabblers could stand against those of competent men like Martin and Isherwood because mechanical engineering was not yet a profession capable of excluding interlopers.

Historian Monte Calvert offered a template for professionalization. To be considered a profession, mechanical engineering required several things. First, engineers needed a technical knowledge base combining both theory and practice. Secondly, recognition of the need for prolonged and specialized training in the field was necessary. To effect this, educational institutions devoted to development of this knowledge base had to be established. Third, members of the profession had to be socialized and controlled, primarily accomplished through a license to practice or concern for the use of

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41 Buhl, “Mariners and Machines,” p. 715. Buhl was writing about an identical situation that occurred during the war, when Dickerson won a contract for the engine of U.S.S. Idaho over the objections of Engineer-in-Chief Isherwood.
professional titles. In 1858 mechanical engineering was devoid of all of these critical components. Steam engineers learned their job on the job, through an apprentice-based method too loose to be defined as a system. As a result, avocational 'engineers' such as Dickerson were able to intrude in their world.

Dickerson claimed expertise in engineering, but he garnered government contracts because he had potent allies. His connections to powerful men in politics, finance, and the press in Washington and New York allowed him to win the Pensacola engine bid over the objections of Martin and other Navy Bureau chiefs. Isherwood was not free of Dickerson once the Pensacola contract was signed. When the Civil War broke out, Dickerson's patrons swung more contracts to him over Isherwood's protests. The two men would be very publicly at odds over theories of thermodynamics and engine design. The repercussions of their disagreement over thermodynamic theory wrought lasting changes on the pedagogy of mechanical engineering.

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42 Calvert, The Mechanical Engineer in America, p. xvi.
Chapter Six - The Civil War Era: Fighting Engineers

Introduction

The Civil War impacted Navy engineering in three ways, with long lasting ramifications. First, the fleet of steamships expanded by an order of magnitude in a little over a year, from a few dozen to three hundred. By war’s end, the steam fleet approached six hundred vessels. Steam engineering’s new prominence forced the Navy to adjust its administrative organization. It created a separate Bureau of Steam Engineering. As chief of the new Bureau, Benjamin Isherwood ranked with commodores, the most senior officers of the line.

Increased reliance on engineers and the ambiguity of their rank relative to line officers caused the second lasting repercussion for engineers. Engineers had no command authority over line officers, no matter if they had senior rank relatively. This escalated existing tensions between the two groups, and that friction continued to mount over the next three decades.

Third, the standing of Navy engineers as experts came under question during the war. Civilian Edward Dickerson leveled attacks against Isherwood and his philosophy for efficiency in Navy engines. The two men differed in opinion over the thermodynamic properties of steam, each employing his own ideas in power plant designs. In response to Dickerson’s criticism, Isherwood launched a new battery of scientific experiments with steam engines. The empirical evidence collected in these tests helped correct engineering theories of the time. In addition to Dickerson’s assault, a very public display of incompetence saddled the Navy engineer corps. An entire class of ironclad warships
designed by Navy engineer Alban Stimers failed to float when launched in 1864. Millions of dollars went to waste, and relations between line and staff deteriorated further.

One outcome of Dickerson’s attacks and Stimers’ embarrassment was a resolve to improve the theoretical training of Navy engineers. The Naval Academy instituted two concurrent pilot programs in steam engineering in 1866. The first program took four practically skilled mechanics and attempted to instill in them theory and mathematics, with poor results. The second program was more successful. Sixteen college graduates came to Annapolis for two years to refine their theoretical knowledge and gain practical experience with steam engines. The Academy never issued them a formal certificate, but those sixteen men were the first in the country to undertake formal mechanical engineering education beyond a bachelor’s degree. Their curriculum, developed at Annapolis immediately after the war, became the blueprint for engineering education at the Academy in the 1870s.

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Part I – Battles over Expert Knowledge

Strategic Situation in 1861 – Steam Engineering Required

The United States Navy in 1861 was ill prepared for the enormous burdens suddenly placed upon it, despite the ship building programs of the Pierce and Buchanan administrations in the previous decade. The number of steamers of all types including tugs and auxiliaries had grown from fourteen to thirty-nine between 1850 and 1860, and most of the increase was in first and second-class armed screw steamers. These were the largest, heaviest armed, and most advanced American warships of the pre-war era, though they still carried masts and yards for full sail power. The steamers were deep
draft, intended for sailing alone in the open ocean instead of near shore. They were
designed for two missions: worldwide cruising to show the flag, or in the event of war
with Britain, guerre de course. The strategic and tactical mindset of the Navy was mired
in commerce raiding at sea, coupled with the occasional ship-to-ship duel. Despite the
lessons of the Mexican War, naval officers did not train for combined fleet actions, nor
for cooperative operations with the Army.¹

Secession of the Southern states changed the Navy's strategic and tactical
positions. Now the Union's ships would patrol almost exclusively in North American
waters. Compared to global cruising, the ships were relatively close to repair facilities
and coal depots. However, for the blockade strategy to be effective, tactics required
squadrons of men-o'-war to stay on station. Steamers were better than sailing vessels,
because they could intercept or pursue blockade runners no matter the wind direction.

Blockading ships hovered outside Southern ports for extended periods, reacting instantly
to intercept blockade runners. It was essential for the Navy to acquire at least two bases
along the Confederate coasts for repair and fuel replenishment. Without those bases,
ships needing refit would have to leave their position and sail for the nearest Union port.
Fuel replenishment also required ships to divert from their blockade stations to a friendly
port; at-sea refueling was still years away. The round trip from blockade station to port
and back could take weeks, diminishing the strategic effectiveness of the blockade.²

¹ George Henry Preble, Complete List of the Vessels of the United States Navy from 1797 to 1874
² Roberts, Civil War Ironclads, pp. 11-13. Roberts served as a Surface Warfare Officer in the U.S. Navy.
His concise analysis of the strategic and tactical situation facing the Union in 1861 is perhaps the best in
print.
The Union required steamers for other reasons. Without yards in the South, the Navy would have to put to sea an enormous number of blockaders. Coordinated fleet actions would be the order of battle to capture those bases, best accomplished with maneuverable steamers. To throttle the Confederacy, the Union also had to gain control of the major rivers in the interior. Again, steam ships acting in concert were vital, since large sailing vessels could not navigate up and down rivers. For the initial tactical steps required to establish the blockade, and for the blockade strategy itself, the essential ingredient for success was a large fleet of dependable steam powered warships.³

**Changes in Naval Administration**

Reliance on steam plants brought increases in the numbers and importance of Navy steam engineers. An 1862 administrative reshuffling highlighted this new emphasis. The Navy split engineering from its former home as a division in the Bureau of Equipment and Repairs, and elevated it to Bureau status. At the head of the newly created Bureau of Steam Engineering and each of the other seven Bureaus sat a chief, administering operations. Bureau chiefs enjoyed prestige and authority, ranking with fleet-commanding commodores. Commodore was the highest rank in the Navy until the introduction of the rear admiral grade in 1862.⁴

The Chief of the Bureau of Steam Engineering wielded enormous power. The government budgeted tens of millions of dollars for steamers, and decisions had to be made quickly as to the types of vessels, power plants, and boilers purchased or built by

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the Navy. The Chief of the Bureau of Steam Engineering was responsible for the design, construction, and repair of all the Navy's steam machinery. Promoted to Engineer-in-Chief after Daniel Martin's four-year term expired in March 1861, Benjamin Isherwood became the first Chief of the Bureau of Steam Engineering. 

Isherwood as Bureau Chief

In many ways Isherwood was ideally suited to be bureau chief. He had combat experience in the Mexican War, one of only eight engineers still in the Navy who saw action in that conflict. His years at sea running the engines of various ships provided a wide range of operational experience. That practical knowledge complemented the encyclopedia of engine performance data he had amassed in the 1850s. Empirical evidence gathered in his 1850s experiments girded his comprehension of thermodynamics. His judgment was critical to implementing the wartime blockade strategy. In 1861 Isherwood understood better than anyone else the requirements for Navy steam engines.

Speed of Union warships was one factor in engine design, but engine reliability and durability became Isherwood's overriding concerns. He recognized that Navy engines had to withstand the abuse of wartime operations. The blockade required long weeks on station with banked fires under the boilers, ready to provide steam whenever lookouts spotted a blockade runner. Constant operation took a toll on machinery, causing breakdowns that diminished combat readiness. Another hazard was the inadvertent neglect of the volunteer engineers aboard ship. With scores of steamers added to the fleet

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5 Sloan, Isherwood, pp. 46, 83.
6 Combat veteran engineer data compiled from Bennett, Steam Navy, Appendix A, and Hamersly, Records of Living Officers, 1890.
each month after March 1861, the Navy put into uniform hundreds of civilian engine drivers. Many of these men were not familiar with the plants in their charge. The Engineer-in-Chief took all of these factors into consideration when selecting engines for the fleet.

Engine designs originating on the Engineer-in-Chief’s drawing table were characterized by heavily constructed primary components to make them robust. He also simplified where he could; Isherwood’s designs were less complicated than commercial engines. One critical simplification was in the degree of steam expansion used in the cylinders. Relying on the results of the 1858 Smithery engine experiments, Isherwood decided not to use steam expansively. He held that a short steam cutoff did not result in fuel savings great enough to justify the added expense and complication of a patent cutoff valve. The chief wanted compact engines set low in the hulls of the ships, as far out of the way of enemy shot as possible. He settled on a standard for Navy screw war steamers: a horizontal back-acting engine with steam cut off at 7/10 of the piston stroke.

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Figure 12 – Isherwood’s engines for the sloop-of-war Hassalo. The engines were simple, reliable, and compact. At Dickerson’s behest, an 1865 congressional panel investigated Isherwood, his designs, and the Bureau of Steam Engineering in general. It returned a report stating Isherwood’s engines provided a great increase in speed and power over any others. Further, the panel concluded that his philosophy of long steam cut-off was theoretically sound and experimentally proven.

Image Source: Engineering (21 September 1866), p. 208
Expert Knowledge:

Dickerson v. Isherwood

As the Navy purchased long cutoff engines at Isherwood's behest, proponents of the short cutoff trumpeted that he was wasting public funds on inefficient engines.⁹ The most vociferous of Isherwood's critics was civilian Edward N. Dickerson, the lawyer-cum-engine-designer who applied political influence to win the 1858 engine contract for the Navy sloop, Pensacola. A thorn in the side of two consecutive Engineers-in-Chief, Dickerson launched a dispute over steam engine design that ran longer than any of his engines.

Dickerson claimed expertise in steam engineering, but his track record suggested otherwise. He took nearly three times longer than other engine builders to produce the engines for Pensacola, delivered late in 1861. Part of the delay resulted from Dickerson's continual design changes through the construction process. Redesigns forced follow-on changes in the vessel's interior layout and hull, slowing the entire project. When finally delivered, Dickerson's engines were much larger and heavier than specified in the contract. Pensacola's displacement was fixed, so heavier than expected engines entailed a reduction in weight elsewhere. The easiest way around the problem was to diminish the amount of coal carried on board. The ship's bunker space was cut by half, curtailing its steaming endurance and range. Operationally, this meant that Pensacola could maintain its blockade duty for only half the originally envisioned duration before leaving station to refuel. This was bad enough, but other problems with the engines soon became apparent.

⁹ See Sloan's clear and concise discussion of Isherwood's decision process on the steam cutoff. Sloan, Isherwood, pp. 82-96.
Figure 13 - Dickerson’s engine for U.S.S. Pensacola, described as “bewildering” by Navy engineer Frank Bennett. Unlike the comparatively simple long-cutoff back acting engine designed as a standard by the Bureau of Steam Engineering, Dickerson's entire engine and the short cutoff mechanism in particular were complicated and prone to breakdown. Source: Rice, “Marine Engines,” H.R. Report No. 8 (30 January 1863), 38th Congress, 2d Session, pp. 26-28. Image: Naval Historical Center.

The ship never attained its contract speed, and the engines broke down completely after only two voyages.\textsuperscript{10}

The inadequacies of Dickerson’s design were easily discerned as Pensacola sat idle and crippled at the dock. Disgusted, Isherwood denounced the engines to Secretary of the Navy Gideon Welles. In one official report, the chief termed the engines “absurd creations of ignorance” and Dickerson’s theories “the conclusions of a charlatan.”\textsuperscript{11} Isherwood typically used heated rhetoric when he criticized the work of engineering amateurs. In this case, the engineer met his match when it came to abusive language.


\textsuperscript{11} Isherwood, “Report to Welles” (17 February 1863) \textit{Senate Ex. Doc. No. 45}, p. 6.
Dickerson defended his design by publishing vicious personal attacks aimed at Isherwood. In a letter to the New York Times written under the pseudonym *Vindex*, the New York lawyer railed that Navy engines were “a national disgrace.” He accused Isherwood of being an “engine driver,” raised beyond his station by wheedling political favors from Abraham Lincoln.\(^2\) In a public letter to Gideon Welles, Dickerson dismissed Isherwood’s experimental data as “nonsense in rows of figures,” and ridiculed the Navy man’s conclusions about the expansion of steam as “profound ignorance.” As for the engine designs emanating from Isherwood’s office, Dickerson termed them “ridiculous,” “worthless,” and “vastly inferior to their predecessors, and practically useless.”\(^3\) Pride was one reason for Dickerson’s vigorous defense, but he had even more pressing concerns.

Prior to and early in the war, engine contracts seemed promising opportunities for financial gain. Dickerson wanted more lucrative government jobs. He used his political connections to win the bid for two other power plants, to be installed in *Algonquin* and *Idaho*. The lawyer’s prewar Washington contacts eroded after secession, however. He had been closely allied with two member of the Naval Affairs committee, Senator Yulee and chairman Stephen Mallory, both from Florida. The pair of congressmen went south in 1861, and Mallory accepted Jefferson Davis’ offer to be Confederate Secretary of the Navy.\(^4\) Given his close prewar ties with Stephen Mallory, Dickerson had every reason to

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fear being branded disloyal. By claiming that the Bureau of Steam Engineering was not performing well for the Union, Dickerson deflects criticism of his own loyalties.

Always a theatrical orator in the courtroom, Dickerson was equally entertaining in his attacks on Isherwood. He accused the Engineer-in-Chief of "childish ignorance" and in reference to the long cutoff, ridiculously averred that Isherwood did not comprehend basic physical properties and engineering principles. Secretary Welles regarded Dickerson's complaints as "the vilest misrepresentations and fabrications that could well be gathered together." He believed the accusations against Isherwood to be "wholly unjustifiable and inexcusable." However, the lawyer made his complaints very public. He went so far as to claim that Isherwood forced contractors to provide kickbacks for

Figure 14 - An illustration from "Uncle Sam's Whistle" depicting Dickerson catching pennies from heaven in the form of government engine contracts. He sits on a throne of oil dash-pots, in which he collects the money falling from above. He uses Isherwood's published engineering texts as a footstool. Watt and Mariotte look down on him, and the "gentle breeze of fame" pushes him through the clouds. Source: "Uncle Sam's Whistle," pp. 12-13.
contracts. Accusations of corruption in the Bureau of Steam Engineering made good press and Dickerson’s newspaper friends played along by airing his views. With the lever of public notice, Dickerson used his remaining contacts in Washington to force the Committee on Naval Affairs to launch an investigation of the Bureau of Steam Engineering.15

Dickerson’s attacks forced the Engineer-in-Chief to protect himself and his Bureau. In 1863 Isherwood attempted to discredit the lawyer’s short cutoff argument by collecting more evidence to support the results of his 1858 Smithery engine experiments. Under Isherwood’s orders Navy engineers tested several types of engines and noted the benefits, drawbacks, and relative efficiency of each variety. The results of these trials were published in a two volume series, Experimental Researches in Steam Engineering.

In the preface Isherwood argued that knowledge of the physical laws of steam was too imperfect to allow confident application of descriptive mathematics. To state this another way, thermodynamic theory was not well enough understood to employ calculus to design effectively. Only by "honest sagacious experiment, long and frequently repeated" could true knowledge be distilled. Isherwood fully expected his experimental evidence to be subject to counterattack by Dickerson and other supporters of the high-expansion theory, but accepted that as a burden concomitant with his position as an engineering reformer.16 Under Isherwood, Navy engineers conducted more practical

experiments to ascertain the true physical properties of operational steam engines. They revisited earlier experiments to assess Mariotte’s law. Again the experiments showed that the theoretical gains of short cutoffs were offset during normal operation by an increase in condensation in the cylinder, which reduced the engine’s power.

In the years following the crisis of the union, tremendous advances were made in the efficiency of marine steam engines. Jacketed cylinders minimized heat loss, refined designs increased efficiency, and better manufacturing techniques and materials allowed higher pressure engines and boilers. Even so, as late as 1881 engineers continued to theorize and to experiment in their attempts to find the most efficient cutoff point for steam engines. By the end of the century, high-pressure high-expansion engines were widely used.\(^1\) However, the experiments performed in the 1850s and 1860s by the Bureau of Steam Engineering illustrated that even under ideal conditions Isherwood’s engines were nearly as fuel efficient as the more complicated, less reliable high expansion models at the time.

Despite the experimental results obtained by Navy engineers, the dispute between Dickerson and the Engineer-in-Chief dragged on interminably. Dickerson’s political connections in Washington and financial links in New York helped him win engine contracts for four vessels during the war. Dickerson continued to denigrate Isherwood

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United States. An Exposure of its Condition and the Causes of its Failure, etc. (New York: John A. Gray and Green, 1864). Ultimately Isherwood replaced Dickerson’s Pensacola design with low-expansion engines, and the ship served faithfully until 1912.


U.S. Navy Lieutenant J.J.D. Kelley stated that a steam ship of 3000 tons had to allow 2200 tons for machinery and coal on a voyage of a given length in 1864. Due to improvements in steam engine technology and iron hull design and construction, by 1881 a ship of the same size sailing the same route required only 800 tons for coal and machinery. See Jerrold J. D. Kelley, A Question of Ships: The Navy and the Merchant Marine (New York: Charles Scribners' Sons, 1884), p. 29.
and Navy engine designs after the war. The respected British journal, *Engineering*, reported in 1866 on another competition between Isherwood and Dickerson engines, this time placed in the paddlewheel steamers *Winooski* and *Algonquin*, respectively. Dickerson's engine again broke down during dock trials. In addition, the engine was poorly balanced, leaving the port paddlewheel immersed nearly four feet deeper than its starboard companion. This ridiculous situation was corrected temporarily only by stowing 73 tons of ballast on *Algonquin*'s deck. The machinery was deemed a failure, and rejected. Yet operational experience and a large body of scientifically collected experimental data could not silence Dickerson's public assaults on Isherwood.

Isherwood's experiments and the actual performance of his engines demonstrated to his superior, Secretary Welles, that the engines the Engineer-in-Chief recommended were well suited for the missions at hand. Without those experiments, the Navy might have been convinced to incorporate less reliable ship engines in a time of national crisis. Though some British contributors to *Engineering* and the partisan editor of the *Army and Navy Journal* continued to criticize Isherwood's long cutoff engine through 1868, Gideon Welles believed Isherwood proved "mentally superior to any of the chief engineers" in the Navy during the war, and asserted his engines had "rendered good service and given better satisfaction than any others." Welles was not alone in this assessment.

The 1865 congressional investigation into the replacement of Dickerson's *Pensacola* engines with Isherwood designs vindicated the Engineer-in-Chief. The Committee on Naval Affairs studied ships' deck logs, engine room steam logs, and repair

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records from the Bureau of Construction and Repair. The committee concluded that despite Dickerson’s claims to the contrary, Navy engines were more robust and economical than others, and that ships powered with them were faster than those driven with civilian designs. Further, the committee noted that the long cutoff of Isherwood’s engines was very close to the accepted British practice for marine engines. Dickerson had posited that Navy engines’ long cutoff was an engineering aberration, but the committee showed that Dickerson’s short cutoff diverged from common practice to a far greater extent.  

Even with the support of Welles and the favorable results of the 1865 investigation, Isherwood was never quite able to stifle Dickerson’s criticism. This was only one front in the battle he and the engineers fought for mechanical engineering authority and professional prestige. The long cutoff dispute gave birth to a new movement among Navy engineers. In the postwar period they began a long siege to establish sole possession of expert mechanical engineering knowledge. They needed to organize a sequential program to gain this expert knowledge, for some very visible wartime problems called into question their supposed expertise.

Alban Stimers and the Light Drafts

The most damaging engineering debacle to hit the Navy since the Hunter wheels of the 1840s was the complete failure of the Union’s shallow water ironclad program. Deeply involved with the project was Union Chief Engineer Alban Stimers. He joined the Navy as an engineer in 1849 and worked his way through the ranks to Chief Engineer by

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1858. In 1861 the Navy detailed him to work on the Stevens Battery in Hoboken. The project had limped along through the 1850s, never nearing completion and undergoing seemingly perpetual design changes. Soon after the Civil War broke out, Congress allocated more than $750,000 for the “immediate completion” of the Battery if a panel of engineers returned the opinion that the ship could be made an efficient steamer.21 Problems with the Stevens plan continued, and the Navy soon re-assigned Stimers to supervise construction of John Ericsson’s ironclad, Monitor. Stimers served aboard that ship when it dueled the Confederate ironclad Virginia. In an episode reminiscent of Benjamin Isherwood’s Mexican War combat experiences, Stimers accepted command authority during the Battle of Hampton Roads. He took charge of the gunnery division and was the only officer in the turret after the Executive Officer left it to relieve the injured captain on the bridge.22 Stimers’ behavior on this and other occasions made him a great favorite of Assistant Secretary of the Navy Gustavus Fox, who became a powerful patron for the engineer.

Stimers’ wartime duties and a close association with Ericsson made the Navy engineer an enthusiastic advocate of the monitor-style ironclad. A monitor craze swept the Navy and nation after the engagement with Virginia, and production of a variety of the type became a top priority. Chief Engineer Stimers had no formal training in shipbuilding, but he had overseen aspects of the Stevens Battery and original Monitor construction. After the national press reported his performance at Hampton Roads, he

21 Gideon Welles, “Letter from the Secretary of the Navy in Relation to the Expenditure of the Appropriation for the Completion of ‘Stevens’s Steam Battery’,” (28 May 1862) House of Representatives Executive Document No. 121, 37th Congress, 2nd Session.
was a public figure, and Gustavus Fox selected him to oversee the highly visible construction of the light drafts. The subsequent travails of the light draft monitor program brought into sharp relief the limits of Navy engineering.\textsuperscript{23}

Stimers’ project ultimately foundered on a variety of rocks. Some of the problems that hindered the light drafts were similar to those faced by Robert Stevens in the 1840s. In 1863 the nation’s industrial machine had matured far beyond the point where the demands of a single iron ship could choke it. However, wartime production in weapons, railroad locomotives, and other iron-intensive goods increased demand for labor and iron far above available supply. A further similarity between the twin failures of the Stevens Battery and the light draft monitor program occurred in the design process. Stevens never produced a finished plan of the vessel, and felt obligated to redesign the ship in response to improvements in ordnance. Alban Stimers also redesigned throughout the construction process.\textsuperscript{24} This slowed construction and increased costs, exactly as Stevens had experienced in the 1840s and 1850s.

Additional problems saddled the light draft program. Stimers had sole authority over the design and construction process, with no oversight from higher-ups. When the Chief Engineer launched his first long overdue and over budget monitor hull, he was dismayed to learn that he and his assistants had quite literally miscalculated. The vessel was supposed to sit in the water with fifteen inches of freeboard, the distance between the water’s surface and the top of the deck. Instead, the bow sat about seven inches out of the water, and the stern was two or three inches \textit{below} the surface. When all requisite

\textsuperscript{23} Roberts, \textit{Civil War Ironclads}, p. 206. “Light draft” is the maritime terminology for vessels that draw a small amount; that is, vessels that are submerged only a few feet below the waterline. Light draft usually decreases a ship’s stability, so most ocean-going vessels are deep draft.

\textsuperscript{24} Roberts, \textit{Civil War Ironclads}, pp. 59-60, 66-68, 134.
equipment and stores were put aboard the ships, the entire class of vessels designed and
built under Stimers' guidance simply would not float. At the base of the problem was an
error in a lengthy but straightforward hydrostatic calculation. If Stimers and his Navy
engineer assistants had accurately predicted the mass and displacement of the finished
ship and its machinery, all other problems would likely have been forgiven. Instead, the
Navy Department was left in 1865 with a very public multimillion-dollar humiliation.
The light drafts and Stimers become laughingstocks for a bitter Congress.26

The light draft monitor debacle and the continuing dispute between Isherwood
and Dickerson pointed out shortcomings in the training of the Navy's engineer corps.
These difficulties forced the Navy's leaders to recognize the need for theoretically and
scientifically educated, practically skilled men to design and operate the fleet's technical
systems. When the war ended in 1865, the Naval Academy returned to Annapolis from its
wartime home in Rhode Island. The next year the Navy moved toward rectifying the
situation in its engineering corps.27

The Civil War Era, Part II – Postwar Engineering at Annapolis, 1866-69

Fixing the Engineer Corps

Steam engineering education for all midshipmen was the highest priority for the
Academy under its first postwar superintendent, Vice Admiral David Dixon Porter. In his
1866 report to the Secretary of the Navy he commented on the large appropriation for
Annapolis' new Department of Steam Engineering. Porter spent the $20,000 allocation to

25 Roberts, Civil War Ironclads, pp. 159, 161.
26 See comments by Senator Hale, Congressional Globe (30 January 1865), p. 491. Hale got the chamber
laughing by his criticism of the light drafts and those associated with it, particularly Asst. Navy Sec. Fox.
27 Report of the Secretary of the Navy 1866, p. 33.
put up a new building and equip it with “a beautiful propeller engine” designed by Isherwood. The admiral was complimentary to Isherwood, and termed the engine “a monument to the skill and perseverance of the engineer-in-chief.” In a reference to the dispute between Isherwood and Dickerson, Porter averred that this was the best type of engine available, “although efforts have been made to bring it into discredit.” The engineering building also held classrooms and laboratories; henceforth all midshipmen would undergo “a full theoretical and practical course of steam” during their four years at the Academy.28

Contemporary ideas about the Academy’s curriculum can be further discerned by the report of the 1866 Board of Visitors. All but one of the members approved of the new prominence of engineering in cadet training. The Board deemed engineering knowledge “indispensable for the efficiency of a naval officer” and ranked it second only to seamanship in importance. The Academy used multipliers to determine the importance of subjects; the Board recommended increasing by 50% the steam enginery multiplier. The Visitors were of the opinion that every midshipman at the Academy needed practical steam training and “should understand the construction of steam machinery, and the methods of using, repairing, and preserving it.” Rear Admiral John Dahlgren noted separately his conviction that ordnance should rank higher than steam engineering in the midshipman curriculum.29 Dahlgren was an ordnance specialist, so his position was hardly surprising.

28 Report of the Secretary of the Navy 1866, p. 75.
One conclusion reached by the Board of Visitors seemed to contradict their emphasis on technical education. The Visitors declared that they did not think that line officers needed extensive scientific training. They suggested eliminating advanced mathematics, including descriptive and analytical geometry, and calculus. They wished to see chemistry, mechanics, and physics subsumed under steam engineering. The Board asserted that Porter agreed with their view that the Academy should be of “a more directly practical character.”

The Board of Visitors’ recommendation to decrease science education by subsuming various branches under steam engineering at the Academy was approved in May 1866. However, after a year of implementation, the subjects of chemistry and heat and combustion were restored to the Department of Experimental and Natural Philosophy. This suggestion to decrease the importance of science was odd, particularly since scientific training was responsible for the career advance for Dahlgren and at least one other member of the Board. Commander Daniel Ammen had participated in the U.S. Exploring Expedition under Wilkes, served two tours with the Coast Survey, joined a scientific expedition on the Paraguay River, and also served at the Naval Observatory. Ammen and Dahlgren both might have espoused the virtues of science and mathematics. However, the war might have changed the career outlooks for science-oriented officers.

Men who made names for themselves through antebellum science projects applied their influence to win wartime combat billets: Porter, Charles Wilkes, and Dahlgren all insisted on high commands. Ammen captained several steamers during the conflict,

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30 Report of the Secretary of the Navy 1866, p. 79.
31 Letter, "Welles to Porter," (11 May 1866), RG 405 Letters Received by the Superintendent, 1865-67: Box 9, Folder 11; Letter, "Welles to Porter," (19 June 1867), RG 405 Letters Received by the Superintendent 1865-67: Box 9, Folder 11.
including new ironclads. Science might have been a path to increased prestige during peacetime, but when war came these officers were convinced that only command at sea could elevate them to join the Navy’s elite. Perhaps the 1866 bias against the Academy’s science curriculum exhibited by Dahlgren and Ammen was based on their own experience. The academy did not exist when they were midshipmen, yet they were all able to pick up the math and science they needed to rise through the ranks.

New Engineering Programs

Congress and the Navy recognized that practical knowledge of steam engines was requisite for the next generation of line officers, but Navy engineers needed a deeper theoretical understanding of their subject. Unsure how best to achieve this, in 1866 the Academy introduced two experimental curricula. The first pilot program of 1866 brought two young men to Annapolis, and in 1867 another pair joined them. These men had a background in practical shop work; each was required to have at least two years of employment in a factory or machine shop. They came to the Academy as Cadet Engineers to build theoretical knowledge in advanced mathematics and physics. This limited program proved abortive, however. After one year the original duo could not master their studies and left the Academy. During the summer practice cruise of 1868 one of the two remaining Cadet Engineers died at sea. Only the fourth man, C.P. Howell, completed the course in 1868. He commenced a long career in the Navy, eventually becoming a Chief Engineer.33

33 A.H. Rice, H.R. 351 (March 1864) 38th Congress 1st Session; Report of the Secretary of the Navy 1866, p. 33; Bennett, Steam Navy, p. 665; Annual Register of the United States Naval Academy at Annapolis, MD., for the Academic Year 1867-68 (Washington, D.C.: Government Printing Office, 1867), pp. 36-38.
A second Academy program ran alongside the attempt to impose theory on practical men. The strategy for this program was the opposite of the first: men already competent in the science and theory of engineering would enhance that knowledge with an additional two years of study, combined with practical operational experience with engines. In 1866 the Navy recruited a group of men from leading scientific schools: Harvard, Yale, Rensselaer Polytechnic Institute and a few other colleges. About fifty engineering students responded to the Navy’s posted advertisements for steam engineers. They submitted to a competitive exam at Annapolis, and the top sixteen accepted the Navy’s offer to enter a two-year program in steam engineering. These men had earned engineering bachelor’s degrees already: the Annapolis program would be graduate education for them.\(^\text{34}\)

The originator and chief proponent of this plan was Benjamin Isherwood. He outlined his idea in a report to Welles in early 1866, then actively encouraged it as part of his drive for increased rank for engineers. In his annual report for 1866 he wrote, “…elevating the status of the corps…[and] making first and second assistant engineers commissioned officers, renders it practicable to now obtain for the lower grades the graduates of the first scientific schools of the country.”\(^\text{35}\)

Gideon Welles also saw value in a scientific corps of naval engineers. In his annual report for 1866, he noted that “the gross loss, delay, and embarrassments experienced during the war in consequence of the ignorance, inefficiency, and incompetency of many of the engineers, admonish the government of the necessity of educating and training men of ability to this highly responsible profession.” This was a

\(^{34}\) Report of the Secretary of the Navy. 1866, pp. 33, 82; Bennett, Steam Navy, pp. 665-666.
\(^{35}\) Report of the Secretary of the Navy. 1866, pp. 178-179.
direct reference to Alban Stimers' light draft debacle. Welles continued that the cadet engineers would form a "highly scientific and useful class, indispensable to the service and more useful, perhaps, in the design and construction of engines than in duty afloat."\textsuperscript{36} To achieve this, the Academy would set a national precedent for engineering education.

**Technical Education in U.S.**

To comprehend how the 1866 Annapolis curriculum differed from that offered elsewhere, it must be compared to American higher education in contemporary technical and scientific universities. Technical education was in its early adolescence at the time of the Civil War. While West Point and a handful of established colleges convened courses in civil engineering, mechanical engineering education was rooted in shop culture. The three best respected American colleges offering engineering curricula were Rensselaer Polytechnic Institute, Lawrence Scientific School at Harvard, and the Sheffield Scientific School at Yale.\textsuperscript{37} Only RPI differentiated among branches of engineering. It offered tailored programs for mechanical, civil, and mining, but the four RPI graduates entering the Naval Academy engineering program in 1866 earned their degrees in Civil Engineering.\textsuperscript{38}

The classes taught in the Engineering division of RPI in 1865-66 provide the benchmark for mechanical engineering education of the time. The nineteen students of that year's senior class had studied for four years in the civil engineering program. In

\textsuperscript{36} *Report of the Secretary of the Navy 1866*, pp. 33.
\textsuperscript{38} The RPI graduates were John Q.A. Ford, Charles Rae, Holland Stevenson, and Francis Trevor. Source: *Annual Register of the Rensselaer Polytechnic Institute 1866*, p. 13.
their first year, they undertook algebra and geometry, natural philosophy (physics),
geodesy and drawing. More algebra, geometry, physics, and drawing followed in the
second year. Subjects in their penultimate year included calculus, electricity, chemistry,
and more geodesy. They also studied mechanics of both solids and fluids. Building on the
natural philosophy presented in the first year, professors taught the physics of acoustics
and optics in year three. In the final year at RPI, more solid and fluid mechanics, more
chemistry and drawing, machine theory, and geology rounded out the civil engineering
course. The course in mechanical engineering program was identical to it, with two
exceptions: machine drawing replaced construction drawing, and a class on the
construction of machines and their placement was substituted for road engineering.\(^\text{39}\)
In 1866, the RPI course was the standard against which all others were judged.

In contrast, the engineering course at Harvard’s Lawrence Scientific School
varied a great deal from Rensselaer’s. Unlike the four-year RPI engineering curriculum,
Harvard conferred a Bachelor of Science degree after one year of instruction. Often men
left the school without completing the requirements for the degree, studying only a few
subjects before departing.

There were thirty-five men studying engineering at Harvard during the 1865-66
academic year, six of whom accepted positions at the Naval Academy in the fall of 1866.
Lectures and exercises in surveying and drawing, algebra, geometry, and trigonometry sat
at the base of the Harvard engineering education. Advanced mathematics training took
the form of analytical and descriptive geometry, and differential and integral calculus.
Along with instruction on the properties of building materials, the principles of

\(^{39}\) Annual Register of RPI 1866, pp. 24-26.
mechanics and their application to machinery and engineering completed the classwork.\textsuperscript{40} The Lawrence Scientific School at Harvard produced men with knowledge of mathematics and the ability to conduct surveys. To become the kind of mechanical engineer envisioned by the Navy, graduates of the program would still need years of experience in machine shops and more substantial theoretical education.

\textbf{Annapolis Curriculum After the Civil War}

The Naval Academy inaugurated a rigorous program in response to the inadequacies of engineering curricula offered at civilian institutions. The sixteen engineers admitted to Annapolis in 1866 came from the best technical schools in the country. The men’s performance on the admissions test demonstrated their mastery of integral and differential calculus, so this group did not study those subjects at the Academy. Though already proficient at the drafting table, the men expanded their skills with pen and ink by practicing mechanical drawing. Plans and estimates for the construction of boilers and engines, iron ships, and mill works were other areas of study. The Navy instilled practical skills in iron ship-building to correct the shortcomings made apparent by the light draft debacle.\textsuperscript{41}

\textsuperscript{40} \textit{A Catalogue of the Officers and Students of Harvard University, For the Academical Year 1865-66} (Cambridge: Sever and Francis, 1866), pp. 73-75, 77-78. Robert Thurston noted that in the forty-six year period from 1846 to 1892, the Lawrence Scientific School graduated only 155 engineers. Source: Robert H. Thurston, "Technical Education in the United States: Its Social, Industrial, and Economic relations to Our Progress" \textit{Transactions of the American Society of Mechanical Engineers} Vol. XIV (New York: ASME, 1893), pp. 924-925.

The Harvard students who went to Annapolis in 1866 were Cyrus Foss, George Gates, Jones Godfrey, William Moore, Charles Purdie, and Frank Symmes.

\textsuperscript{41} Letter, "Welles to Porter," (14 February 1867) RG 405 Letters Received by the Superintendent, 1865-67: Box 9, Folder 11. \textit{Annual Register of the United States Naval Academy at Annapolis, MD., for the Academic Year 1867-68} (Washington, D.C.: Government Printing Office, 1867), pp. 37, 41; \textit{Annual Register of the United States Naval Academy at Annapolis, MD., for the Academic Year 1868-69} (Washington, D.C.: Government Printing Office, 1968), pp. 40, 43. Calculus remained part of the USNA
The engineers at the Academy also focused attention on management of machinery, consisting of practical exercises with steam engines and boilers. This experience was vital to the engine-driving roles they would fulfill as Third and Second Assistant Engineers aboard ship. Once joining the fleet, the engineers would also command the fire room. Their course in Chemistry acquainted them with lubricating oils, coals and fuels, and ores. Additional practical exercises included working with hand tools in wood and metals shops.

On the theoretical side, the men studied physics, particularly steam and heat. An extensive course in mechanics covered engines and motors. The Annapolis program bolstered the standard practical and theoretical education acquired by the 1866 engineer class in civilian institutions, but in one critical way it was not simply more of the same. In a significant contribution to engineering education, in 1867 the Naval Academy introduced thermodynamics into the theoretical training of American engineers.

Years earlier Benjamin Isherwood had pointed out mechanical engineers' woeful incomprehension of thermodynamic theory: this was the root of his fight with Dickerson. The engineering students who entered Annapolis after the war studied thermodynamics to correct this. The first and second laws of thermodynamics had been proposed one and two decades prior respectively. The Annapolis curriculum's distinct sections on thermodynamics set the Naval Academy program apart from all others in the country.

The new curriculum served as a model for other schools: in 1870 the premier civilian

Cadet Engineer course. C.P. Howell, the sole remaining participant in that program, studied calculus in the first term of his second year. In addition to Yale, Harvard, and RPI, some other schools contributed men to the class of Acting Third Assistant Engineers. Charles Bray studied Civil Engineering at Brown prior to his admission at Annapolis. Source: Orren Henry Smith (ed.), *The Tufts College Graduate: A Quarterly Magazine Published by the Alumni Association* Vol. 28 (September 1919 – August 1920), p. 121.

42 *Register of the Naval Academy* 1867-68, p. 41; *Register of the Naval Academy* 1868-69, p. 43.
43 *Register of the Naval Academy* 1867-68, p. 41; *Register of the Naval Academy* 1868-69, p. 43.
technical institution, RPI, added thermodynamics to its engineering courses. With the foundation of calculus and descriptive mathematics in place and an understanding of thermodynamics, Annapolis-trained mechanical engineers in the late 1860s possessed the most advanced theoretical engineering education in the nation.

**Engineers’ Social Place in Navy**

The Annapolis engineers were different from their civilian counterparts, and they were unlike the other men training at the Academy in 1866. They were not ‘Cadet Engineers,’ the title assigned to the four practical engineers in the alternate program. Instead, the sixteen were classified as ‘Acting Third Assistant Engineers.’ Bennett noted that this was in deference to the men “being too old and too well educated to be made cadets of…. At an average age of almost twenty and a half years, the engineers at admission were about four years older than the incoming class of line midshipmen. This made them very close to the average age for the graduating class of midshipmen, who for four years had been immersed in Navy culture at the Academy in Rhode Island and then in Annapolis. Differences between the engineer class and the other men at the Academy did not end there.

The Acting Third Assistant Engineers were granted special privileges: they lived outside the Academy walls and were not part of the cadet organization, “being more on the footing of junior officers taking a post-graduate course.” In an institution where chain of command and tradition were vitally important, these engineers were anomalous.

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44 *Annual Register of the Rensselaer Polytechnic Institute, Troy, N.Y., for the Academical Year 1870-71* (Troy, NY: Wm. H. Young and Blake, 1871), p. 23.


46 Bennett, *Steam Navy*, p. 666.
They were not quite cadets, since they were not subject to the same restrictions of the line midshipmen. They clearly were not civilians, but just as obviously they were not officers. How the line officers of the Academy and the cadet midshipmen in the regular line officer training program viewed the Acting Third Assistant Engineers is an open question. Neither Bennett nor Soley addressed relations between the new group of engineers and the other men at Annapolis.\(^{47}\)

Overall relations between Navy engineers and line officers became more and more of a problem in the years that the Acting Third Assistant Engineers studied at the Academy. Although Naval Regulations prohibited officers from publishing anything “having in view the praise or excuses of any person in the naval service,”\(^{48}\) officers refused to be gagged. Anonymous articles featuring the invective of both sides appeared regularly in the pages of the *Army and Navy Journal*, *New York Times*, and *New York Tribune* throughout the late 1860s. The tensions between officers of the line and staff would nearly consume the Navy in the following years. Evidence that it affected the 1868 engineers is found in their subsequent careers. Within one year in the fleet, a quarter of the graduating 1868 class of “indispensable” engineers resigned from the Navy.\(^{49}\)

**Conclusions**

The Civil War illustrated in high relief the shortcomings of the Navy’s steam engineering. Alban Stimer’s failed light draft monitor efforts were an example of a flawed administrative system more than anything. Stimers’ patron, Assistant Secretary of

\(^{47}\) Soley, *Historical Sketch*, p. 110. Peter Karsten is likewise silent on these issues.


\(^{49}\) The four men who resigned in 1869 were Frank Symmes, Charles Bray, Theron Skeel, Francis Trevor.
the Navy Gustavus Fox, had placed him in a position for which he was not qualified. Stimers was not a naval constructor, and the demands of the task exceeded his professional abilities. Construction of the complete vessel was a systems engineering project, but such holistic approaches to technical programs were far in the future.

After the war, the Navy’s budget shrank, officers and men left the service in droves, and Congress forced a reduction in the number of ships to prewar levels. It seems contradictory to this policy of retrenchment for the Naval Academy to have recruited a new group of engineers in 1866. The explanation is that Gideon Welles and Benjamin Isherwood retained enough power to carry through on the idea, which was originally proposed by the Bureau chief. The two men saw in the plan a way to pre-empt future engineering difficulties like those experienced during the Civil War.

Benjamin Isherwood’s problem during the conflict was an inability to close the debate with Dickerson over expert knowledge. The Navy engineer was armed with reams of experimental data and the proof of reliable steamers blockading the Confederacy, but criticism of his engines continued throughout the war and after. Dickerson’s power lay not in his own engineering capabilities, but in his political, financial, and press connections. Saddled with an enormous engineering and administrative workload, Isherwood could not devote enough attention to quelling the cries of his main detractor.

Criticisms of Isherwood’s designs were typically published in three journals, and the editors of all of them had personal reasons to air the views of the Navy man’s enemies. The editor of the Army and Navy Journal, William Conant Church, was a vocal supporter of John Ericsson. Ericsson was an engineering rival of the Bureau Chief, so Church published almost anything that could injure Isherwood.
The editors of the *New York Times* were connected to Dickerson’s financial backers. To retain the flow of federal funds into their coffers in the face of Dickerson’s repeated machinery failures, it was imperative for the avocational engineer’s views and attacks to be published. Further, the *Times* developed pro-line sentiments during the war, and became one of the chief mouthpieces of the line in the postwar years.

The British journal *Engineering* had a less petty reason to denigrate U.S. Navy vessels and power plants. The British watched nervously as the American industrial machine girded for war. As hundreds of capable new ships poured into the American fleet, the previous supremacy of the Royal Navy eroded. Concern for national defense could have been a factor in the publication of articles critical of Isherwood.

In 1866 Gideon Welles, Isherwood, Porter, and other high-ranking naval officers and administrators cooperated to remedy some problems in the technical training of officers. The curriculum changes effected at the Naval Academy in 1866 were direct responses to the light draft disgrace and the debate over thermodynamic theory. Welles probably was the most high-minded of the triumvirate. His writings show that his support for the new curriculum was based on the long-term best interests of the Navy and nation. Isherwood was self-interested; he wanted increased rank and prestige for engineers. By attracting bright, well educated engineers to the Navy, he could achieve that end. Porter probably believed that by increasing line midshipmen’s education in steam engineering, he could all but eliminate engineer officers from ships. His actions through the end of the decade lend credence to this.
Chapter Seven – The Line-Staff Conflict

Introduction

One noticeable participant in the growing intraservice strife was Vice Admiral Porter. In his first two years as academy superintendent, Porter took an active interest in engineering education, even going so far as to make recommendations for new technical textbooks. He also spent part of the Academy’s allocation to obtain a set of working models of steam engines, model steam pumps, a library of engineering works, and drawings of the marine engines then used in the Navy.¹

Porter insinuated himself in every department of the Academy, dismissing or demoting professors in several departments, and placing new professors and department heads as he saw fit. Annapolis Assistant Professor Charles Magnan sent a letter to Charles Sumner, expressing his dismay over the situation. He wrote that Porter’s intent was make professors dependent on his authority; this gave Porter the power to promote incompetent students, or hold back students who displeased him. The superintendent’s arbitrary behavior created an uproar among the teaching staff, and several resigned in disgust.²

Initially, the superintendent spoke highly of engineers and the Navy-built, Isherwood-designed engines he arranged to install in the new steam engineering building. In his 1867 report to the Secretary of the Navy he opined of those engines “…at no time

² Letter, “Charles Magnan to Charles Sumner,” (15 July 1867). Copy held in Harvard University Widener Library, U.S. Naval Academy, Annapolis, Md. History and description: Pamphlet box, call no. EduCU 7718.50.867. USNA engineering instructor Robert Thurston quit in this period. Magnan was not attached to the Academy in the 1867-68 academic year. Whether he resigned or Porter dismissed him is not known.
have they failed to perform satisfactorily...first, owing to their fine material and workmanship; second, the care exercised in their erection and adjustment and management under steam, and care exercised at all times, by intelligent engineers, to keep them in good working order." This sentiment was similar to that expressed by the vice admiral in his report the previous year. However, as 1867 drew to a close, several factors caused Porter to reconsider his opinion. When the engineers completed their studies in 1868, Porter cancelled the Academy’s progressive program.

Porter determined to abort Annapolis’ separate engineering program, but he maintained an interest in the steam curriculum for the line even after his offensive against the engineers. In 1869 the vice admiral insisted the line midshipmen read technical textbooks he preferred over those selected by the instructors. To understand why he made the decision to eliminate the special engineering program and was able to enforce it, an eye must be cast over events during and soon after the Civil War.

In the late 1860s Bureau of Steam Engineering chief Isherwood and Annapolis Superintendent Vice Admiral David Porter squared off. At issue was the prominence of engineers in the postwar Navy. Funds and billets were in short supply. The Navy budget shrank by 80% after 1865, and a glut of officers left over from the war filled the ranks. Promotion all but ceased. Isherwood clamored for increased rank for his engineers, concomitant with their increased responsibilities in the steam fleet. Porter vehemently opposed this. Open rancor between line and staff ensued, and as Porter consolidated his power in the Navy, he was able to quash the engineers’ bid. After canceling the Annapolis

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3 Porter, "Naval Academy," Report of the Secretary of the Navy 1867, p. 75.
4 Letter, “David D. Porter to Naval Academy Superintendent” (18 June 1869), copy held in USNA Archives, Office of the Superintendent: Letters Received by the Superintendent Box 14 Folder 10 "Textbooks 1865-70."
program, the Admiral dethroned Isherwood from the Bureau at the end of the chief's second term and exiled him to California's Mare Island Navy Yard. With their path to enhanced status in the Navy temporarily blocked, the engineers began to explore new courses to earn respect.

Wartime expansion of the engineers' corp

The steam engineers of the antebellum Navy were a relatively small group of working men. They cut their engineering teeth in machine shops and railroads before joining the service, and their naval duties centered primarily on driving the engines of the fleet. Only a few men advanced to the higher echelon of engineering, designing propulsive machinery and boilers. On the eve of the war, fewer than two hundred Navy engineers serviced three dozen steam-powered combat ships. Nearly one thousand men comprised the entire line officers corps. The small number of engineers dispersed among them presented no threat to the fleet's social status quo.5

In response to secession the Navy greatly expanded its muster rolls and built, bought, or modified vessels for steam. Faced with a shortage of experienced naval technicians, the Navy recruited civilian engineers to operate the new vessels' plants. By the wartime peak, the Navy Register listed almost 500 regular and nearly 2000 volunteer engineering officers. Engineers gained prominence as steamers steadily displaced sailing

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vessels in the blockading fleet; by war's end the Navy possessed nearly 600 steamers. Secretary Welles noted the responsibility of the engineer: "The safety of the ship, its efficiency — even the honor of the flag — depends in a great degree on their sobriety and vigilant attention to duty." Welles often took a longer view of the Navy Department than other politicians and naval personnel. His sentiments toward the engineers were not shared by many of the Navy's line officers.

The Navy was divided into two major corps of officers, line and staff. Line officers were the authority aboard ship. They commanded the crew, and were responsible for maneuvering the ship, firing the guns, and navigating. Only line officers could give orders to other subordinate line officers or enlisted men, except in rare cases. The staff corps included paymasters, surgeons, and engineers. The officers of the engineering division could direct the actions of the men in the engine and fire rooms, but the engineers and other staff officers in turn were subservient to every line officer in the ship.

**Historiography of Line-Staff Conflict**

Often naval historians are dismissive of the staff officers' position. For instance, in his 1979 work, Benjamin F. Cooling took a blindered view of the problems between engineers and line officers. Relying on a single secondary source, Cooling shrugged off sixty years of corps rivalry. He attributed the entire dispute to the aristocratic "deck elite" fighting off "upstart mechanics... of the dirty engine room." Cooling apparently took

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7 Gideon Welles, General Order No. 40 (5 August 1864) *General Orders, 1863 to 1887*, p. 18.
writings of line officers at face value, and claimed that the line's "legitimate grievances" included complaints about the efficiency of Navy-designed steam plants. Without supporting evidence, he stated, "Given the state of naval engineering and technology at the time, the engineer corps failed to produce the optimum in effective and efficient warships."\textsuperscript{8} Cooling neglected sources that might have balanced that picture, and he failed to suggest a model for that ideal warship. Without so much as a comparison to foreign warships of the time that arguably were more effective and efficient, the reader is left to wonder what vessel would have been pleasing to the author.

In contrast to Cooling's simplistic discussion, Lance Buhl produced a nuanced scholarly analysis. His study was a reaction to historian Elting Morison's work on resistance to technological change in the U.S. Navy. Morison wrote that Navy officers in the late 1860s found steamers, particularly Benjamin Isherwood's masterpiece fast cruiser \textit{Wampanoag}, "a disruptive energy in their society." The line officers did not like "the feel" of the novel technology.\textsuperscript{9} In Morison's eyes, the Goldsborough Board condemned Isherwood's ship and engines simply for that reason. Buhl found more reasons for the apparent rejection of steam technology.

Buhl noted that the steep contraction of the Navy after 1867 reduced the American fleet to a "third rate force." This left naval officers feeling humiliated and convinced that their career mobility was in jeopardy. The upsurge in the number of staff officers only heightened this anxiety; line officers began to see their very careers under threat. Those with political clout took their complaints to Congress. Each time that body

\textsuperscript{8} Benjamin Franklin Cooling, \textit{Gray Steel and Blue Water Navy: The Formative Years of America's Military-Industrial Complex 1881-1917} (Hamden, CT: Archon Books, 1979), p. 21. Cooling's lone source for this analysis was Karsten's \textit{Naval Aristocracy}.

reviewed and acted on individual promotion cases, it leapfrogged men over others in the promotion line. This increased the outcry from other officers, creating a hydra.10

A problem in Buhl’s assessment is Isherwood’s place in the line-staff conflict. Based on Morison’s work, Buhl wrote, “most members of the Goldsborough Board had been trained quite literally as sailors. They were conditioned to define comfort in terms of a certain way of navigating and to identify beauty in the set of the sails. To that breed of men, Morison argued, the development of steam propulsion was a hostile act threatening time-honored ways.”11 Buhl’s assumption that the Board was composed of sailors was incorrect; he never examined the careers of the Board members to inform his view. If he had, he would have realized that Porter composed the Board from Isherwood’s detractors. This is a point I will return to later in this chapter.

Porter, the Goldsborough Board, and the line-staff conflict receive scant attention in the principal history textbook assigned today at the U.S. Naval Academy. Historian Nathan Miller incorrectly describes Porter as inherently conservative and therefore opposed to steam technology. Miller contends other conservative officers opposed Isherwood and Wampanoag simply because the engineer subordinated sail to steam. Of the line-staff conflict, he wrote only that there was “considerable squabbling.” Nowhere did the author delve into the complexities of intraservice strife.12

Naval historians are not unique in their oversight of the technological trends developing in the postwar Navy. Hunter Dupree, eminent author of Science and the Federal Government, claimed that “the decline of the scientific function in the military is

12 Miller, The U.S. Navy, pp. 144-146.
one of the basic drifts of the last third of the nineteenth century.” Dupree’s characterization of the period is inaccurate. The Army’s contribution to science and technology might have dissipated, but the Navy was poised to assume the leading role for the remainder of the century.

**Tensions grow among officers**

Tensions grew between the line and staff during the rebellion. At the root of the problem was an enormous change in proportions of line and staff officers. Before the war, the line enjoyed a 2:1 majority over the entire staff, and 4:1 over the engineers. By 1865 the number of line and staff officers in the regular Navy was close to even, and the ratio of line to engineers shrank to 2:1. The proportions were similar among the more than five thousand volunteer line and staff officers added to the Navy during the war. Line officers felt threatened by this increase in staff officers, particularly the various grades of engineer.\(^{13}\)

Discord between line and staff arose in the course of the war, most notably when recently commissioned and promoted line officers gave orders to long-serving staff officers. An article in *The Nation* explained why a staff officer might find the situation untenable: “an aged [staff officer] asking the executive officer, not born when he entered the service, for ‘permission to go on shore,’ reporting to the beardless ensign pacing the quarterdeck that he has ‘permission to leave the ship,’ … manifests an inherent absurdity....” This was not a hypothetical case. It occurred regularly during the war, and continued afterwards.

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\(^{13}\) Preble, *Complete List*, pp. 23-30.
One instance in 1868 involved a Chief Engineer, Mortimer Kellogg, who faced censure and the threat of a court-martial from the Secretary of the Navy as a result of his actions aboard U.S.S. DeSoto. Kellogg was charged with depriving a twenty-one year old midshipman of command of the ship’s dinghy, and assuming command himself. The engineer had been in the Navy since 1852. His long service included significant assignments, Matthew Perry’s mission to Japan and the laying of the transatlantic cable foremost among them. By 1868 the veteran resented taking orders from junior line officers, inferior in age and experience. The complaint about the dinghy incident was only one of three offenses reported. Another charge against the Chief Engineer was refusal to obey an order of DeSoto’s executive officer. For the staff, interacting with a ship’s executive officer was one of the sorest points.14

Originally, the executive officer was known as the ‘first officer’. He served as the intermediary between the captain and the rest of the ship’s complement. The executive conveyed and executed the captain’s orders, but no orders originated with him. The chain of command passed through the executive in both directions. All reports to the captain had to be submitted initially to the executive, and anyone wishing to communicate directly with the captain had to obtain permission from the executive first. The executive had other responsibilities alongside this intermediary function. He exercised general supervision over all departments of the ship, reporting daily to the captain on each

14 “The History of the Naval Staff Question” The Nation (February 23, 1871), pp. 121-122; General Order No. 87 (September 7, 1868) General Orders, p. 67; Official Register of the Officers and Midshipmen of the United States Naval Academy, Newport, Rhode Island, December 31, 1863 (Newport, RI: Frederick A. Pratt, 1864), p. 18; Bennett, Steam Navy, pp. 136 and Appendix A.
department’s situation. As an operational manager, the executive was critical to the efficiency of the ship.

In addition to operational management, the executive also performed important social functions. He presided in ‘wardroom country’, the exclusive domain and mess area of commissioned officers. Wardroom country embodied an important social barrier between the officers and other ranks. The isolation of officers from the sailors, one line officer wrote, was necessary to give them “the prestige necessary for the performance of [their] duties.” The line jealously guarded wardroom privileges, and reacted when engineers began to intrude in officers’ country.

Anti-staff Arguments of the Line

Line officers objected to increasing the rank of staff officers because they felt it would cause the breakdown of shipboard discipline. They carried their arguments to the New York newspapers. The journals picked champions: the Tribune supported the staff, prompting articles and letters to the editor in the pro-line Times. The line officer author of one letter railed against the Tribune’s “misrepresentations.” He complained that the Tribune’s reporting misled readers to believe that staff officers were “depreciated, disparaged, and rudely and harshly dealt with by the officers of the line.” He continued that the line’s opposition to giving the staff assimilated rank was “purely and simply for the good of the service and the preservation of discipline.”

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16 Regulations 1870, paragraphs 360, 975-976; “The History of the Naval Staff Question,” p. 121.
Line officers particularly disliked a Navy regulation passed in 1867 that accorded First and Second Assistant Engineers all of the privileges of commissioned officers. Though a lack of space in ships’ wardrooms forced the assistant engineers to room and mess as before, the line wanted to end the encroachment of engineers and other staff. One wrote, “Sailors, as a class, are ignorant and unruly and if they see the equals or superiors of their commanding officers attending to the sick...or repairing an engine, they naturally lose a portion of their respect for the Commander.”\textsuperscript{18} On this shaky logic, line officers interfered with engineers’ right to officers’ country in the postwar period.

Navy regulations issued at the end of the decade codified the place of line and staff officers in the staterooms of wardroom country. Line officers claimed the starboard side cabins, assigned according to rank beginning with the forward room. The staff officers of the ship lived on the port side, with the senior engineer occupying the forwardmost compartment. A companionway physically separated line and staff while at sea, and other regulations reinforced that partition. The regulations ordered that in all officer messes the senior line officer would preside, except in engineer messes, where the senior engineer was responsible.\textsuperscript{19} Engineers messed alone.

This statute distanced engineers from the rest of the officer contingent while at sea. In the close confinement of a warship, this seclusion from the other officers was

\textsuperscript{18} Regulations 1870, paragraphs 360, 975; U.S. Navy Regulation Circular No. 6 (20 July 1867), General Orders, p. 62; Anonymous, “Naval Rank” Washington Chronicle (16 November 1869), p. 6. This document was also printed in part in George Robeson, “Assimilated Rank in the Navy. Letter from the Secretary of the Navy in Answer to A resolution of the House of 14 th December, 1869, inclosing the record of proceedings of the board of officers appointed to take into consideration the subject of assimilated rank in the navy,” 41st Congress, 2d Session House of Representatives Executive Document No. 99, January 28, 1870.

\textsuperscript{19} Regulations 1870, paragraphs 975, 976, 979. The best scholarly discussion of the importance of barriers and privileges to various shipboard physical spaces is Greg Denig, Mr Bligh’s Bad Language: Passion, Power and Theater on the Bounty (Cambridge: Cambridge University Press, 1992), particularly pages 19-34.
significant. The Navy was an institution in which symbolism, tradition, and hierarchy were woven through everyday affairs. The fact that engineers ate their meals segregated from the ship's authority conveyed a powerful message to the men in the ranks: engineers had no authority, and therefore were not worthy of the enlisted men's respect.

The line used peculiar justifications for the imposition of this social division. One of the line's arguments directly attacked the engineers' identity as naval officers. The line averred that staff officers were "noncombatants." The staff cried foul. One of their number noted in a public letter that unless personally attacked, the commander of a ship was every bit as much a noncombatant as a ship's surgeon. When they first proposed this delineation, the line based the combat demarcation on the authority to command men in battle. By Navy regulation only the line possessed command authority. However, the experiences of Isherwood in Mexico and Stimers at Hampton Roads illustrated that the staff command barrier sometimes necessarily blurred in the heat of combat. When ordered to do so by line officer superiors, engineers could and did fire guns at the enemy. In emergency situations they could lead men in battle, relinquishing command authority to the line when the crisis passed. Engineers did not clamor for command authority, preferring to leave that to the professional officers of the line. But, when the situation arose for them to act in this capacity, they were ready to answer the call.20

The line's definition of a combat officer was further muddied when they attempted to link it to exposure to danger. Events of the war proved that every man on a

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warship shared the risk during an engagement with the enemy. When ships struck torpedoes, they often sank within minutes. This was particularly true with ironclad steamers. In one famous case at Mobile Bay, the monitor *Tecumseh* struck a Confederate torpedo. The ship sank in less than two minutes, carrying to their deaths all but twenty-one of the 114-man crew. Most of the survivors were turret crew; only one coal heaver survived from *Tecumseh*’s engine room complement of six officers and thirty-seven men. Below decks in the machinery compartments, engineers seldom escaped sinking vessels.  

All men in the ship shared the risk of drowning if the vessel sank, but additional dangers faced the black gang. Rapidly moving machinery crushed hands and arms. Even worse, burst steam pipes and boilers scalded men in the engineering spaces; scalding accounted for one in five Navy deaths in action. Wartime statistics should have disarmed the claim that engineers were not combatants. They suffered the Navy’s highest casualty rates during the conflict.  

**Staff Legislative Efforts**

Line officers employed these arguments because they felt insecure in the face of a rising tide of engineer prominence. This discomfort grew as staff officers began to assert themselves through the 1860s. Benjamin Isherwood led a series of campaigns advocating increases in the size, rank, and status of the staff corps. As a representative of the Chief

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Engineers, he petitioned Congress as far back as 1852 to enlarge the engineer corps. In 1862 after rising to Bureau Chief, he had written a letter to Senator Charles Sumner on behalf of the entire Navy engineer corps. In that letter he disparaged Senate Bill 158, introduced by Ohio Senator John Sherman, brother of the soon-to-be famous general. Sherman's bill would have reduced the number of engineers in each grade and reduced their status in relation to the line, thus undoing “at one blow, all the gradual, and well-considered legislation of eighteen years in regard to the Corps of Naval Engineers.” As the importance of steam in the Navy increased, Isherwood believed the time was ripe to redefine the engineer’s place in the service. The Chief dedicated nearly half of his Bureau’s annual report for 1867 to an argument for increased rank for his engineers. “The navy is now, and must ever continue to be, exclusively a steam navy, depending wholly, for all the efficiency to be derived from the prompt, certain and rapid locomotion, on its engineer corps,” he pointed out. Isherwood continued that the Navy depended on its engineers: “Their position is, in fact, second to none, and in the nature of things cannot be made second to any.” He recommended increasing the rank of Bureau Chief to rear admiral, and an increase in the relative rank of all grades of engineer.23

The Engineer-in-Chief was reacting specifically to political developments in Washington. A new law directed that the engineers should maintain their rank and pay as officers, but provided greater benefits for the line officers. On July 25, 1866 Congress passed an act doubling the number of line commissions in the Navy, thus allowing promotions for those officers. New laws during the war had created the grades of admiral, commodore, and lieutenant commander for the line, in effect reducing the rank of the

staff. Turn of the century naval historian Frank Bennett was a Navy engineer, and he knew many of the staff officers personally affected by this legislation. He wrote that they interpreted the law as a deliberate snub, and watched with dismay as their own opportunities for advancement dwindled with the fleet’s postwar contraction.  

Porter as Anit-Staff Architect

Advocating the diminution of staff rank was Vice Admiral David Dixon Porter. His temperament had not changed since the Mexican War. He eagerly sought engagement with the enemy at sea, and was always ready to attack. He despised inactivity, and his superiors noted that recklessness, resourcefulness, and energy were his strongest suits. Used to conflict, perhaps the admiral needed the invigoration of the battle with the staff. His long career in steamers demonstrated that he was not an opponent of technology. Nonetheless, he led the campaign against steam engineers in the post-Civil War Navy.  

David Dixon Porter literally grew up in naval vessels, either in the United States Navy or the Mexican Navy, where his father served following his court martial. A host of deployments sailing in and commanding steam ships combined with the six years of Coast Survey scientific training could have made the younger Porter an advocate of Navy engineering. Those experiences and his decision to stay loyal to the Union in 1861 marked him as one of the new breed of professional Navy officer that emerged in the antebellum period. Yet Porter did not strictly adhere to that emerging cultural model. As

24 Report of the Secretary of the Navy 1867, p. 23; Bennett, Steam Navy, p. 607.
Dear Harris,

Above you have the camels 'screwing' the Niagara, below I give you the cost of doing it. I am a great hand at making cost estimates, but I think what I can in with such gross issues I suppose.

Figure 15 - One example of David Dixon Porter's transgression of gentlemanly conduct - an obscene sketch made by Porter in a private letter to his brother-in-law, Gwinn Harris Heap. The letter opens: "Dear Harris - above you have the camels 'screwing' the Niagara, below..." This is in reference to an Army plan to acquire camels for operations in the American West, to be shipped to the United States from the Middle East in the vessel. Porter was given command of the ship Supply in 1855; he and two Army officers made trips to the Levant in 1855 and 1856 and returned with camels later used by the Army. This letter was written in January 1855, at the start of what was the first of many successful collaborations between Porter and Army officers.

Source: David Dixon Porter Papers, Box 14 Folder “Memorials of Rear Admiral David D. Porter” Library of Congress Manuscript Division, Washington, D.C.
a young lieutenant, he displayed some of the characteristics of the aristocratic naval ideal, including challenging a fellow officer to a duel. However, he never quite lived up to that ideal. Gideon Welles noted that Porter was willing to lie if it could improve his own position.26 A further transgression of the gentleman ideal was Porter’s tendency to be course and vulgar. These characteristics were not associated with the aristocratic gentlemanly model, but hardly were surprising to find in a man who grew up in foreign ports in the rough world of sailors.

Porter was an advocate of steam engines since his assignment to the steamer *Spitfire* during the Mexican War, and wanted to be given charge of a modern steamship upon conclusion of that conflict. Instead he was assigned back to the Navy Hydrographic Office and Coast Survey. After a few years, he got his wish for command of a new steamer. In response to need for improved communication with the West Coast after the Gold rush, the government subsidized construction of a fleet of ships to run mail routes. The contracts for them usually stipulated that Navy officers would command the ships. Porter obtained leave to captain a mail steamer running routes from the Atlantic to the Pacific. Returning to the Navy in the mid 1850s, he captained the ship *Supply* during two missions to the Levant to purchase camels for the U.S. Army.27 When the Civil War broke out, Porter’s aggressiveness and leadership abilities propelled him through the ranks.

Navy Secretary Welles placed Porter in command of the steamships of the Mississippi Flotilla in 1862, promoting him ahead of more senior officers who lacked the younger man's "vim and dash." The Secretary was aware that Porter harbored some

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character flaws. He noted Porter’s boasting, his "excessive and not over-scrupulous ambition," and his proclivity for "cliquism." Nicknamed “Black Dave” by his sailors, Porter acquitted himself well in the West, and Welles awarded him command of the North Atlantic Blockading Squadron. He rose meteorically from lieutenant to rear admiral as a result of his success in steamers.28

In 1866 Porter granted modest credit to engineers’ wartime contributions. The flag officer commended their performance, stating that he had never known any of the two thousand engineers under his command to shrink from any service.29 Opinions expressed by the mercurial Porter were likely to change with circumstances, and his view of engineers was about to undergo a reversal. The brunt of this sea change would be borne by Benjamin Isherwood, longtime chief advocate for his corps.

Porter’s early opinion of Isherwood can be discerned from his official letters. In 1847 he submitted to the Navy Department an unsolicited commendation of that engineer’s wartime shipboard service. Porter wrote that he was “well satisfied” with the engineer’s conduct on board and ashore, noting that they were often under enemy fire. He closed the note with an accolade: “permit me to say that I have always been perfectly satisfied with you in the official duties of your profession and would always be satisfied to have you under my command.” Perhaps Spitfire’s 1847 grounding incident during Isherwood’s deck watch started to dispose Porter negatively to the engineer. Perhaps the phrase “under my command” is especially significant. What is clear is that beginning in 1864 Porter felt that the Engineer-in-Chief was acting above his station and wished to

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28 Welles, Diary v. I, pp. 157-158. The nickname “Black Dave” was scrawled next to David D. Porter’s biographical entry in a copy of Hamersly, Records of Living Officers 1890 in the author’s collection. This volume was formerly owned by a naval officer, who penned the note.
bring him down. The admiral aired a different story about Isherwood's abilities, claiming that he had removed the engineer from *Spitfire*'s engine room in 1847 for "incapacity."  

If this were an isolated incident, Porter could be forgiven for a slip of memory, egregious though it might have been. It was, however, symptomatic of a pattern in that officer's behavior. Gideon Welles wrote that he "did not always consider David to be depended upon if he had an end to attain, and he has no hesitation in trampling down a brother officer if it would benefit himself." Welles took this view of Porter after witnessing the tactics the officer employed against his own foster brother, David Glasgow Farragut. In 1862 Porter encouraged the Secretary to appoint Farragut to command of the Gulf Blockading Squadron, about to attack New Orleans. Within weeks Porter sought to have Farragut removed from his command and retired so Porter could take the prestigious position himself.  

Ambitious to a fault, David Dixon Porter always looked out for himself.

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Porter’s Reign

Welles appointed Porter Superintendent of the Naval Academy after the war. The admiral improved the polytechnic education of the line midshipmen at Annapolis, and allowed the formation of the two engineering pilot programs. As long as Navy engineers remained mere engine drivers under the command of the line, Porter and other like-minded officers were content. However, in Porter’s second year at the Academy Isherwood sought prestige the admiral felt should be reserved for the line.

Porter altered his position on steam engineering after Isherwood’s 1867 challenge to the line officers’ dominance. Porter wanted absolute control of the Navy; if Isherwood succeeded in gaining higher rank and more power for the engineers, it would necessarily detract from Porter’s supreme authority. More than that, Porter’s behavior suggests he maintained a personal dislike for Isherwood. In conversations with his assistant at the Academy, Commander John Walker, Porter maligned Isherwood. Walker was the
nephew of Senator Grimes, and Porter manipulated both men. Walker began to visit the Capitol every few days in 1868. Before long, Porter had Grimes' ear through this link. The Senator had supported the staff officers and Isherwood throughout the war. At Porter's instigation he now became intensely hostile to Isherwood and the entire engineer corps, and altered his legislative efforts accordingly.32

The engineers also tried to influence legislators on Capitol Hill. Their bonds to the seats of power were tenuous, however. One of the Academy's Acting Third Assistant Engineers attempted to be heard on the Hill. In April 1868 John Peck sought permission from Superintendent Porter to travel to Washington; the vice admiral denied his request. Peck disobeyed, and proceeded to the offices of senators on the Naval Committee. Apparently the engineer chose to visit a senator not disposed toward the staff, for a complaint immediately appeared on Secretary Welles' desk. The complaint stated that Peck "visited Washington in an unauthorized manner for the purpose of interfering with the legislation of Congress." When word filtered back to Annapolis, Porter filed charges against the engineer.33

Welles responded by immediately revoking Peck's appointment to the Naval Academy. In a letter to Porter, the Secretary noted that "The Senate suggests that if Engineer Peck be reprimanded 'it would be timely and proper to dwell upon the enormity of boring Senators and Representatives, especially members of the naval committee' with


33 Gideon Welles, "Letter to Vice Admiral Porter, Superintendent of the Naval Academy, 14 April 1868" USNA Archives Record Group 405 (Records of the Naval Academy) Office of the Superintendent - Administrative Records Relating to Midshipmen and Cadets, 1846-1925. Letters and Reports Received by the Superintendent Relating to Individual Midshipmen, 1846-1888 Box 5 Folder 8.
suggestions for Congressional action." This was not the first time that congressmen heard from Annapolis, and it would not be the last time they expressed their boredom with the line-staff conflict. Welles stressed that "the Members of Congress felt wearied with the constant importunities, in matters of legislation, of the young gentlemen connected with the Academy."34

If the Academy’s younger line officers and staff cadets were busy on the Hill, Porter was relentless. The admiral wrote letters to Congress, appeared in sessions, and agitated among his connections for the creation of a Board of Survey to run the Navy. It would be composed of three admirals, which would supervise and control all of the bureaus. The vice admiral found a willing accomplice in the Senate, who introduced a bill to form Porter’s board. Welles was convinced the board would effectively supersede the Secretary, would perform no labor, and would be exempt from all responsibility. If the Board of Survey bill passed, Porter undoubtedly would be installed as its head. The Secretary described the admiral as "uneasy, scheming, ambitious, wasteful in expenditure, partial and prejudiced as regards officers, a most unfit administrator of civil affairs, though brave and full of resources as a commander." If he ran the Board, his character weaknesses would have a deleterious effect on the entire Navy.35

With complete usurpation of power in the admiral’s mind, Porter would brook no threat to his authority. Isherwood's attempts to improve the status of the engineers elicited

34 Letter, "Welles to Vice Admiral Porter," (14 April 1868). Congressmen complained through the 1870s that the grievances aired by corps of the Navy bored them. The New York Times reported, "The question of rank between the line and staff in the navy still agitates that branch of the Government, and bores the House Naval Committee." Source: New York Times (24 March 1870), p. 1
Secretary Welles reconsidered the revocation of Peck’s appointment to the Academy, and reinstated him ten days later. Source: Gideon Welles, “Letter to Vice Admiral Porter, Superintendent of the Naval Academy, 24 April 1868” USNA Archives RG 405 (as above).
a vigorous response from Porter. To curb the engineers’ power in the fleet, the admiral
publicly recommended replacing steamers with sailing vessels equipped with auxiliary
steam power only. These ships would cruise under sail, in view of the changed strategic
situation facing the peacetime Navy. This saved the cost of coal and was supposed to
improve the practical seamanship of officers and men. Line officers embraced this policy,
as evidence by a letter from “Artaxerxes” to the editor of Army and Navy Journal: “This
is retrenchment of the most practical kind, the saving in fuel alone being immense. But if
our ships are to cruise under sail, it is obvious that they will not require a large corps of
engineers, firemen, etc., hence we find that the proportion of this corps allotted to the
ships of the new fleet is reduced to a minimum, another important item of
retrenchment.”36 The pseudonym is revealing: Artexerxes III was a Persian king who
ascended to the throne after butchering his brother’s family. Porter attacked the
engineering officers, vying to recast the Navy to the line’s mold.

Porter maneuvered throughout 1868 and 1869 in his campaign against the steam
engineers. He allied himself with the Radical Republicans before the presidential election
to increase his political clout. Sitting in a lame duck cabinet, Gideon Welles noted with
disgust the lengths the admiral would go to win over Grant: Porter publicly averred to the
general’s total abstinence from alcohol. The admiral made the improbable assertion, “I
have never known [Grant] to taste, nor have I ever heard of his touching intoxicating
liquors of any kind, not even wine.” This statement was part of Porter’s careful
cultivation of Grant. He invited the general to Annapolis often after his nomination. The

36 “Artaxerxes,” Letter to the Editor, “Our Naval Administration,” Army and Navy Journal v. 7 (4
December 1869): 243.
invitations continued after Grant’s election, and though he had not yet been inaugurated, Porter ordered him to be greeted with Presidential salutes.\textsuperscript{37}

By these means Porter strengthened his position. He also worked to weaken the engineers, spreading dissension among them. The flag officer enlisted the aid of ambitious Navy Chief Engineer James King, who coveted Isherwood’s position at the head of the Bureau of Steam Engineering. King petitioned former Assistant Secretary of the Navy Gustavus Fox and friends in the Senate to remove the bureau chief. These appeals fell on the ears of President-elect Grant. Political pressure mounted, and immediately after Grant took office he appointed Philadelphia merchant A.E. Borie as Secretary of the Navy. Borie was a figurehead; Grant telegraphed Porter to come to Washington and take charge of the Navy Department. The Admiral immediately relinquished his position at the Academy and traveled from Annapolis to Washington aboard a special train. One of Porter’s first acts after Grant’s inauguration on March 4, 1869 was “an onslaught on Isherwood.” Porter ordered King to relieve Isherwood; chiefs of several other Bureaus soon found themselves reassigned, as well.\textsuperscript{38}

\textbf{Isherwood Banished}

For the past eight years Isherwood had enjoyed a position of authority in the center of power, Washington, D.C. Now, with Porter presiding over the Navy, the former Bureau Chief found himself banished to Mare Island, California. This punishment for the


\textsuperscript{38} Sloan, \textit{Isherwood}, pp. 226-229, 231; Welles, \textit{Diary v. III}, pp. 549, 551-552; West, \textit{Second Admiral}, p. 320. Isherwood and King were well acquainted, having served together for years. King was one of the engineers who worked with Isherwood during the boiler and Smithery engine experiments in 1858. See Isherwood, \textit{Engineering Precedents}, pp. 3, 85, 145. Porter’s relief at Annapolis was John Worden, captain of U.S.S. \textit{Monitor} at Hampton Roads.
leader of the staff insurgency did not satisfy the admiral. Porter next convened a special investigative board headed by Rear Admiral Louis Goldsborough to examine all Navy steam machinery afloat.

At the heart of the investigation was Isherwood’s engineering masterpiece, the fast cruiser *Wampanoag*. With the engineer isolated on the West Coast, his ship stood as the target for line officers’ contempt and a proxy for the staff. The unarmored *Wampanoag* could make an incredible seventeen and a half knots, faster by far than any other ship afloat. It was designed for *guerre de course*, attacks on British merchant shipping had that nation entered the war on the side of the Confederacy. The war ended before *Wampanoag* and her sister ships could be completed. When she did slide down the ways, her mission no longer existed. There was no need for a fast cruiser in the peacetime Navy, and in the summer of 1869 Porter issued General Order 131 under Secretary Borie’s signature. The order stated in part “the Department can see no reason why our vessels cannot do all their cruising under sail; and officers who fail to economize in this respect will be closely questioned with regard to their reasons for such failure.” The conclusion Porter wished the Goldsborough Board to reach was evident. It if condemned *Wampanoag*, the entire Bureau of Steam Engineering would be discredited and with it the movement for increased staff recognition. The Board conducted its inquiries through the summer of 1869, a period when Porter reached the zenith of his power.39

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Wampanoag and Goldsborough Board

The panel Porter assembled was far from disinterested. The service records of the five-member committee make clear the prejudices each man held against Isherwood. The committee’s head, Rear Admiral Louis Goldsborough, was a product of the sailing navy. He was born in 1805 and at the age of seven became a midshipman at the start of the War of 1812. At age 20 he was commissioned as a lieutenant, and from then until 1854 he served aboard sailing warships. He became superintendent of Annapolis in 1854, and served there for three years. At the outbreak of the Civil War, he was already 56 years old and not up to its demands. His poor performance commanding the steamers of the North Atlantic Blockading Squadron early in the war did not go unnoticed by Gideon Welles. Goldsborough requested to be relieved of command, and the Navy Secretary privately noted he “had no objection, for ‘[Goldsborough] was proving himself inefficient, - had done nothing effective since the frigates were sunk by the Merrimack, nor of himself much before.’” Age and inability to cope with new technology might have combined to make Goldsborough condemn steam engines in favor of sails, but the other members of the committee were all steam men.40

The second line officer on the committee was Commodore Charles Boggs. He entered the Navy in 1826 and was 50 years old when the Civil War started. The man had long experience in steam ships dating back service in Princeton during the Mexican War. In the late 1850s he captained the mail steamer Illinois. His service during the Civil War included command of the steamers Ossipee and Juniata, both vessels provided with engines designed by Isherwood. Engines for the ships were built by an inexperienced and

ill-equipped subcontractor to the firm of Pusey and Jones, and were notorious for mechanical breakdowns throughout Bogg's command of the vessels. Juniata was under repair again through 1868-69, just as the Goldsborough Board convened. Though fault for the engines' unreliability probably rested with the manufacturer – none of the other vessels in the class had problems – the ships' poor records predisposed the Commodore against Isherwood and his designs.\footnote{Hamersly, Records of Living Officers (1890), p. 421; Isherwood, “Report to Welles (February 20, 1863)” Senate Ex. Doc. No. 45, p. 3. Other ships in Juniata's class were powered with engines designed by Isherwood, his trademark two cylinder horizontal back-acting engine. Only Juniata was equipped with a back-acting double-crosstail engine. Secondary sources do not indicate why that engine diverged from the standard Isherwood design. Juniata's machinery was supposed to be built by respected Wilmington, Delaware contractor Pusey and Jones. That firm took on too much work, however, and the engines were subcontracted to a company lacking a proven track record. The official reports on Juniata's and Ossipee's engines suggest the breakdowns were mostly a result of poor workmanship, and partly from mishandling the engine. On one occasion cold water had been applied to a hot component, causing it to fracture. Sources: Anonymous (probably Edward N. Dickerson), Facts in Relation to the Official Career of B.F. Isherwood, Chief of the Bureau of Steam Engineering of the Navy Department (Philadelphia, 1866), pp. 9-10. Report of the Secretary of the Navy Showing the Operations of the Department For the Year 1869 (Washington, D.C.: Government Printing Office, 1969), p. 4. See also Sloan, Isherwood, p. 37; Paul H. Silverstone, Civil War Navies, 1835-1883 (Annapolis: Naval Institute Press, 2001), p. 25. Donald Canney wrote, “The explanation given for these problems was that the contractors had never built marine steam engines and therefore did not have the proper tools for the project.” Canney, The Old Steam Navy, p. 96.}

Three engineers completed the Board. The only engineer to sign unreservedly the report condemning Isherwood's designs was Isaac Newton, who volunteered for engineer service during the war and resigned at its conclusion. Newton served aboard the Monitor, and was an avowed supporter of John Ericsson. The Swedish inventor and Isherwood were at odds throughout the war, each believing he knew the one best design for Navy power plants. In 1866 Newton had published under a pseudonym a letter praising Ericsson and damning Isherwood and his engines. He sent the letter to Welles, President
Johnson, and Congress. With this history, Newton’s decision against Isherwood was a foregone conclusion.\footnote{Bennett, *Steam Navy*, pp. 60, 296. See also Pro Bono Publico, “To His Excellency Andrew Johnson, President of the United States; the Honorable Gideon Welles, Secretary of the Navy, and to the Hon. Members of the Senate and House of Representatives, of the United States, in Congress Assembled 1866.” Newton was the son of a mechanic, and grew up in machine shops. He never had any theoretical training, and was the epitome of the prewar practical mechanic claiming engineering expertise.}

The two other engineers serving on the Board were both on active duty in the Navy. During the war the Board’s senior engineer, Chief Engineer Edward Robie, superintended construction of Ericsson’s *Dictator*-class monitors and then served in *Dictator*. Like Isaac Newton, he was an Ericsson supporter.\footnote{Robie enjoyed a fascinating antebellum career. He served on the steamer *Mississippi* during Perry’s expedition to Japan in the early 1850s, then was one of the engineers on the vessel that laid the first transatlantic cable. Following that billet he rounded Cape Horn on the warship *Lancaster*, and joined the steamer *Saranac* as senior engineer during the search for the lost ship U.S.S. *Levant*. When war came in 1861, he served during the assault on Fort Fisher and subsequent blockade duty. Escaping the tedium of the blockade, the Navy department assigned him to superintend construction of the *Dictator*. See Hamersly, *Records of Living Officers* (1890), p. 313.}

The final member of the Board was John Moore. He joined the Navy as a Third Assistant Engineer in 1853, and was assigned to the office of the Engineer-in-Chief. At the time, that position was held by Daniel Martin, inventor of the Martin water tube boiler endorsed by Isherwood for Navy ships. One of the tasks of the Goldsborough Board was to assess the performance of Martin’s patented boiler; since it appears the rest of the committee was stacked against Isherwood, one wonders the nature of the relationship between Moore and Martin.\footnote{Hamersly, *Records of Living Officers* (1890), p. 315.}

David Dixon Porter could not have convened a committee more likely to find fault with Isherwood. Each member had reason to dislike or to discredit the former Engineer-in-Chief and his designs. The majority opinion showed they did not waver from the task Porter set before them. As the admiral wished, Isherwood and *Wampanoag*
suffered most when the report was published in September 1869. The committee found
the cruiser to be “a sad and signal failure, and utterly unfit to be retained and used as a
vessel of war.” The board members further concluded that not one of the steam ships
afloat was fit to cruise at large in war, or to contend with European warships. They
claimed that the fault for this lay not so much in individuals, but in the administrative
structure of the Navy. In an obvious nod to Porter’s Board of Survey plan, the panel
recommended superseding the Bureau system with a return to a Board of Navy
Commissioners. Goldsborough, Newton, and Boggs toed the line drawn by Porter, but the
panel’s Navy engineers showed a degree of independence.45

Robie and Moore signed the Board’s report, but enumerated significant
exceptions to its findings. The two men refused to denounce Isherwood’s machinery, or
the engineering philosophy of the Bureau of Steam Engineering. In a move that was
almost comic, Robie and Moore declared, “We respectfully concur in the foregoing
report, with the following named exceptions: .... Commencing with the words, ‘In
conclusion,’ and all of the following pages to end of report.” Had they agreed with the
Board’s conclusion, they would have partially indicted themselves; after all, they were
longtime Chief Engineers in the Navy. Given the hostility of the Board members to
Isherwood and the clear expectation that Porter expected them to do his bidding, it is
remarkable that Moore and Robie refused to put their imprimatur on the complete
document. For Isherwood, chafing at his isolation in San Francisco, their reticence must
have been small comfort.46

During the summer of 1869 Porter held complete sway in the Navy, a period that brought intense satisfaction to the son of a disgraced commodore. The vice admiral took full advantage of Secretary Borie, issuing new orders at an unprecedented rate. In the four months that Borie held the position, Porter wrote thirty-four General Orders to the Navy over the Secretary’s signature. By comparison, during the emergency of the Civil War it took Gideon Welles eighteen months to issue the same number of General Orders. Foremost in the vice admiral’s mind was the status of the staff relative to the line. The second order Porter wrote simply stated, “Commanding and executive officers, afloat and ashore, will take precedence over all staff officers.”

Porter demonstrated his dominance over the Navy by the orders he posted. They concerned everything from petty concerns such as the number of boat davits on ships, to the paint schemes and renaming of vessels of war. To reduce the staff corps’ prestige, he ordered the gold lace on their uniforms replaced with colored stripes. Porter’s reach also extended to far more serious matters. He overturned the decisions of courts martial, including the conviction of his nephew, Lieutenant Commander George M. Bache. That officer was charged with inattention to his duty as navigating officer, resulting in the wreck of his vessel. He was suspended from duty on reduced pay for a year, but Porter revoked the sentence and restored Bache’s lost salary. The admiral’s autocracy did not sit well with many in Congress and the Navy. Some legislators began to complain about Porter, but the engineers were nearly powerless against him by 1870.48

Engineering’s Decline

The 1869 Annual Report of the Secretary of the Navy showcased engineering’s decline. The vice admiral ignored engineering in his superintendent’s report for the year. He wrote the entire document without once using the words ‘steam’ or ‘engineering’. He didn’t need to print a single word about the engineers, for he was winning the battle. Porter cancelled the special engineering programs at Annapolis, Isherwood was out of the way, and the Goldsborough Board was about to submit its findings. To complete the picture, a new Secretary of the Navy replaced Borie but seemed willing to follow his precedent and let Porter have his way.

After less than six months in office, Navy Secretary George Robeson issued a stunning attack on steam technology in his annual report. Steamers, he felt, “afford no school of seamanship to officers or men.” The Secretary’s words suggested he had no appreciation for shipboard life on either steamers or sailing vessels. In his opinion, “lounging through the watches of a steamer, or acting as firemen or coal-heavers, will not produce in a seaman that combination of boldness, strength and skill which characterized the American sailor of the elder day....” The only appropriate “school of observation, promptness and command” was “on the deck of a sailing vessel.” Robeson believed the propaganda of the line officers; they claimed that sailing ships made iron men. For Porter to employ this argument was entirely hypocritical, as he spent most of his career

50 Robeson, Report of the Secretary of the Navy 1869, p. 6.
commanding steam vessels. No one questioned the admiral's boldness, strength, or skill in battle.

If an argument was to be made against steamers, a better case took into account their lack of economy compared to sailing ships. Robeson noted that most steam vessels could not carry more than a ten-day supply of coal, and much of their time was absorbed with obtaining fuel replenishments. To save an estimated $2 million in fuel expenditures in a Navy budget that plummeted 84 percent in the four years after the war, he discontinued the re-supply of some foreign coaling stations. The Secretary then issued orders to the commandants of the squadrons, "directing them not to permit the consumption of coal for any purpose which could be as well performed under sail, and requiring a report to the department of any deviation from the general rule, with the reasons for it in each instance." The Navy's mission in the post-war setting reverted to that of a peacetime fleet: global cruising to show the flag under the constraints of vastly reduced funding. There was no place for fast steamers like Wampanoag in that strategic vision. With Porter forcing the decline of steam, the engineers' tension over their position in the Navy continued to mount. They were not alone in their dissatisfaction with the vice admiral.

**Porter's Fall from Grace**

Discomfort with Porter's control grew after the death of Admiral David Farragut in 1870. Black Dave was now in position to be promoted to Admiral of the Navy, but

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some members of Congress did not want any more honors bestowed on him. Particularly vocal was Massachusetts Representative Benjamin Butler. He had been a politically appointed general during the war, and had led the first assault on Fort Fisher in 1865. His attack failed, largely through his own military incompetence. Porter was the commander of the naval fleet supporting the action, and true to form he voiced his low opinion of Butler. Fort Fisher made the two men bitter enemies. After the war, Butler took every opportunity to denigrate the admiral and cause him trouble.\textsuperscript{52}

Porter’s friendship with Grant and support of his political career were well known. As Grant’s re-election campaign began to move forward in late 1870, Democratic scandal sheets overflowed with stories of graft, corruption, and incompetence in his administration. Butler hated the Navy man and might have carried a grudge against Grant for relieving him at Fort Fisher. He conspired to discredit both warhorses.

Butler found a letter Porter had written to Gideon Welles soon after the 1865 fiasco at Fort Fisher. In it an obviously frustrated Porter accused Lieutenant General Grant of seeking credit for the success of the combined forces, when he should have been blamed for the initial failure of the attack. The firebrand admiral, charitably described as “fearless in the expression of his opinions,” claimed that Grant often laid blame elsewhere for his own failures. Butler published the letter in newspapers around the country, causing deep embarrassment for both Porter and Grant. The President informed the admiral that after reading the letter he “lost his faith in human nature.”\textsuperscript{53}

\textsuperscript{52} For details of the enmity between Porter and Butler, see West, \textit{The Second Admiral}, pp. 276-286, 327-334.

Mortified at the public display of the private letter, Porter immediately composed an apologia to the President. He claimed that neither he nor his personal secretary could recall writing the offending article, and that it was at odds with his often stated opinion of Grant. He admitted the letter’s sentiments were “a poor return for the uniform confidence and kindness” the general always had extended to him, and blamed the publication of the letter on party politics.\textsuperscript{54}

The newspapers had a field day with Porter’s supplication to the President. The \textit{New York World} gleefully announced the admiral had “succeeded in performing the apparently impossible feat of kicking himself down stairs.” The \textit{World} continued derisively, “Before this publication there were not a few people in the United States who impiously thought rather small beer of Admiral Porter. Now that Admiral Porter advertises himself as being of the same mind we may look for a happy unanimity upon at least one great question of the day.”\textsuperscript{55}

By Butler’s design, the timing could not have been worse for Porter. In September, before publication of Porter’s letter, Grant nominated him for promotion to fill the vacancy left by Farragut’s death. The President refused to withdraw the nomination even after the letter appeared in December, but the promotion required the confirmation of Congress. Butler and others delayed it, decrying Porter’s character and autocracy and questioning the need for the ranks of Admiral and Vice Admiral. Weeks passed, and Porter suffered an attack of pleurisy brought on by stress. In the meantime Rear Admiral Rowan was nominated to become Vice Admiral; if Rowan were confirmed


\textsuperscript{55} “Porter Upon Porter,” \textit{New York World} (6 December 1870). The breakdown of the relationship between Grant and Porter was temporary; the men reconciled quickly. This was another episode in a pattern of erratic behavior on the part of the Navy man.
and Porter did not become Admiral, he would have no rank in the Navy. Finally, in January 1871 a secret Senate session decided his fate. Porter received his promotion, but the signal was unmistakable: Porter's days as sole ruler of the Navy were over. Though he retained his rank, he never was assigned specific duties. He declined into increasing irrelevance for the remainder of his life.\textsuperscript{56}

\textbf{Conclusions}

After the war the Navy gestated a new breed of scientifically-trained engineers at Annapolis. The Acting Third Assistant Engineers of 1868 established careers in the Navy and the private sector. Those sixteen men were the vanguard of a stream of engineers that soon emanated from the Academy. In 1871 Naval Academy Superintendent John Worden, heroic commander of the Civil War's technological exemplar, U.S.S. \textit{Monitor}, overcome the prejudice of Admiral Porter and admitted a new class of Cadet Engineers. These men and the successive classes that followed them formed the backbone of a new professional mechanical engineering; these Navy engineers impacted American academics, industry, and politics well into the twentieth century.\textsuperscript{57}

Before Porter's fall from grace as the Navy's chief administrator, he undercut the advance of the service's engineers. His attack was a pogrom against the staff officers who clamored for increased status; the engineers were particular targets. It was not a conservative reaction to new technology, but rather an action against that new model of


Rowan was the officer Porter had challenged to a duel years before.

Navy officer: the technically literate engineer. Despite the initial appearances of the Goldsborough Board’s condemnation of *Wampanoag*, all competent line officers realized that steam technology was vital to a modern naval force. The line knew that to be effective warriors, they had to have at least a basic understanding of the technical and mechanical systems in their ships. Despite growing similarities between the training of line and staff, rancor did not end after Congress sidelined the admiral in 1871. The collision of line and staff continued throughout the nineteenth century.
Chapter Eight – The United States Naval Academy, 1871-1883

Introduction

In the 1870s, the United States Naval Academy invented professional mechanical engineering. During that decade, the Navy expanded the cadet engineers’ program from two years to four, the same length as the line school. Similarities grew between the curricula for line and engineer cadets as the proportions of science, mathematics, and engineering classes increased in the cadet midshipmen’s curriculum. Without officially acknowledging the fact, the Navy began to train all of its officers as engineers. Despite the furor over steam engineering fostered by Porter, the Navy recognized that training in theory and practice of steam engineering was critical for those in command.

Even as curricula converged, the Navy was not quite ready for its academy to become strictly an engineering school. Administrators of the academy worked to keep the cadets of the line and engineering corps physically separated. One effect of this division was that engineers developed their own esprit de corps. By the end of the 1870s, engineers formed a distinct Navy subgroup, even differing in appearance from line officers. They were the first professionally trained mechanical engineers in America.

Engineering graduates of the Naval Academy in the late 1870s and 1880s faced shrinking prospects in the fleet. The number of ships in service dropped lower and lower, and conflict between line and staff officers increased in intensity. Navy engineers began to seek new avenues to professional fulfillment: academia and industry.
Hazing in pursuit of esprit de corps

Only two days into the 1876 fall term at Annapolis, the upperclassmen started hazing Fourth Class Cadet Engineer Fredrick Lillebridge. As the first year man walked past Building 5, Second Classman Goold Bull summoned him. Bull, superintendent of Building 5 at the time, ordered Lillebridge to walk through the group of cadets standing inside the entrance, and sit in the superintendent’s chair. Sitting on the desk above him, Bull leaned over and pinched Lillebridge’s cheeks. “What pretty cheeks she has,” he exclaimed, swooning over the young man. Lillebridge sat still as Bull “pretended to make love to him,” waiting for the encounter to end. He had been advised to do whatever the upperclassmen told him to do, “as it would make [his] progress through the Academy much more pleasant.”

In years past, Bull’s behavior toward Lillebridge probably would have resulted in a challenge to duel. By 1876 duels were firmly in the past, and the Navy settled affairs of honor differently. After word got out about the incident, the Academy convened a Board of Investigation and put Bull on trial for offending Lillebridge. The official specification read that Bull hazed Lillebridge, “By pretending that L. was a girl, making love to him, calling him his ‘spoons’, pinching his cheeks, etc., thereby subjecting L. to indignity and rendering him ridiculous.” If convicted, Bull would be dismissed from the Academy.

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Bull conducted his own defense. He asked Lillebridge to describe their relationship. Lillebridge testified that Bull mentored him; he often invited Lillebridge to his room to help him with his studies. Given the rigors of Annapolis academics, this offer must have been well received by Lillebridge. The older cadet was an excellent student. Bull took the most difficult electives in the curriculum and still ranked fourth in his class. Lillebridge’s testimony continued: beyond an academic relationship, the two men were friends. They frequently accompanied one another to and from the Mess Hall, and strolled the campus grounds together. These sojourns occurred both before and after the Building 5 incident. Lillebridge reported that he was unconcerned about Bull’s hazing:
“The occurrence did not affect our relations in the least, and I did not consider myself in any way as being rendered ridiculous.”

The court then questioned Lillebridge, asking him if he felt constrained to comply with Bull’s requests, and if he found it disagreeable to do so. The cadet answered in the negative, that he did not find the Building 5 experience particularly disagreeable. He noted that he did resent being hazed by other cadets, one of whom asked him to be his ‘spoons,’ and several others who requested kisses. Lillebridge stated that he uniformly refused to comply with those requests. After weighing this testimony, the Board found Bull not guilty of rendering Lillebridge ridiculous. Besides providing insight into one form of Navy hazing, the record of Bull’s trial conveys several facets of the Cadet Engineer experience.

**Constructing a new masculine ideal**

The overtly homosexual nature of the encounters Lillebridge described is unmistakable. However, cadet engineers’ hazing of one another was not simply an expression of erotic desire. The older cadets referred to Lillebridge as ‘she.’ They made the junior cadet into a female, a person not as masculine as they saw themselves. What was the difference between the older and younger men, and why did they choose to molest him in this way?

For the cadet engineers, technical and scientific knowledge was the metric of their masculinity. Lillebridge was a fourth class cadet; unlike the older cadets, he had not yet

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3 “Bull court martial,” RG 405.
mastered advanced mathematics, mechanics, and thermodynamic theory. As he and the other fourth class cadets proved their mettle in the laboratory, at drafting boards, and in the classroom, they would grow more manly in eyes of their peers and no longer be hazed.

Engineers' self-worth based on scientific knowledge resulted from the line-staff conflict. The line's assertion that the engineers were non-combatants was an attack on the engineers' masculinity. The engineers realized they could not behave in the same patterns as the line to prove otherwise; they could not beat the line at the combat game. Instead, the engineers constructed their masculine ideals on foundations difficult for the line officers to replicate: technical prowess.

By the 1870s, Navy engineers realized they formed a new breed of officer. The different insignias on the uniforms of line and staff drew the distinction, but engineers went a step further. They consciously altered their physical appearances from the standard presented by the line officers. While the line often wore long beards or extensive facial hair, the majority of engineers went clean-shaven or sported only mustaches. In picture after picture of ships' officer contingents, this difference is noticeable.
Figure 18 – Navy engineer Harry Spangler, with a clean-shaven jaw. Source: University of Pennsylvania Archives.

Figure 19 – Annapolis Superintendent John Worden, wearing the trademark beard of the Line officers' corps. Source: Naval Historical Center.

Figure 20 – A representative image of the appearance of Navy officers. This is the contingent of U.S.S. Vandalia, with President Grant and family sitting in the middle foreground. Many of the Navy line officers show elaborate facial hair, while the two engineers evident on the far left of frame wear small mustaches. Grant, the ultimate line officer (albeit Army), always wore a beard. Source: Naval Historical Center.
Figure 21 - Engineering officers of U.S.S. Alliance in 1887. The men wore mustaches only, not the standard full beard worn by line officers. Source: Naval Historical Center.

Cadet Midshipmen and Cadet Engineers

The Bull-Lillebridge hazing incident obliquely demonstrated the gulf that existed between the midshipman and engineer battalions. Hazing occurred commonly in both groups, but it did not cross over from one division to the other.4 Bull and other upperclassmen in the cadet corps only hazed the younger cadet engineers, never cadet midshipmen. Likewise, the line cadets only hazed their own.

The separation between line and engineering cadets extended beyond hazing. The men did not occupy the same living quarters on campus. Early in the decade, engineers bunked in the academy’s Old Quarters, while the line cadets’ home was in a new dormitory across campus. Lillebridge testified that he and Bull walked from the engineers’ quarters to the Mess Hall together. At meals, the divisions between

midshipmen and engineers was further reinforced. Cadet engineers were organized into special divisions; they were not included in the formations of the cadet midshipmen. The separation of line and staff commenced with their earliest training and continued throughout their careers. After graduation, the engineers and midshipmen would join the fleet at sea; aboard ship, the two groups remained isolated in carefully designated portions of the ship.

Bull’s court martial also indicates changes in the Annapolis curriculum after Porter’s decline. After a three-year hiatus in the course, Superintendent John Worden reconvened the cadet engineer program in 1871. The engineer course re-launched in 1871 was very similar to that conducted 1866-68; it was two years’ duration. However, the sixteen men admitted to the Academy in 1871 were not as well prepared as the earlier group. None had attended the scientific schools at Harvard or RPI. Particularly in mathematics, the cadet engineers stumbled. Recognizing the limitations of the classes admitted in 1871 and 1872, the Academy’s Board of Visitors recommended increasing the admission requirements for all cadets. The Visitors also suggested expanding the engineering program from two years to four to match the duration of the midshipman course. Goold Bull was admitted to a two-year program, but it was lengthened after he and his classmates matriculated. They were members of the first four-year class of cadet engineers.

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5 Cooley, Scientific Blacksmith, p. 43. Later, the living arrangements were modified and fourth year cadets lived together in the Old Quarters. The Board of Visitors in 1875 suggested construction of a new dormitory that could house the entire body of cadets. Source: Annual Report of the Secretary of the Navy on the Operations of the Department for the Year 1875 (Washington, D.C.: Government Printing Office, 1876), pp. 44-45.

6 Annual Register of USNA 1871-72; A Catalogue of the Officers and Students of Harvard University for the Academic Year 1867-68, 1868-69, 1869-70 (Cambridge: Sever, Francis, and Co., 1868-70); A Catalogue of the Officers and Students of Harvard University for the Academic Year 1870-71 (Cambridge: Riverside Press, 1870); Annual Register of the Rensselaer Polytechnic Institute, Troy, N.Y., For the
Navy Engineering Re-Established

The Academy curricula developed in the early 1870s. Instructors drilled their charges rigorously in the fundamentals of mathematics. Throughout their first year, the cadet midshipmen and engineers studied algebra and geometry five days a week. Practical and theoretical steam engineering occupied the cadets for portions of six days per week. The only other classes in the first year were French and Mechanical Drawing.7

The first group of cadet engineers admitted during Worden’s superintendency ranged in age from eighteen and a half to twenty-two years old, noticeably older than the line cadet midshipmen. The Annapolis careers of the sixteen cadet engineers demonstrate their inadequate preparation for the intellectual rigors of the academy program. After the general exam in May 1872, instructors recommended one man immediately discharged. They found him deficient in his studies, and his overall comportment was less than desirable; he had amassed nearly twice as many demerits as his classmates. Eight other men were deficient in the academy’s foundation mathematics classes, but were allowed to continue as long as they passed a re-examination after the summer break. Once spring exams concluded, the cadet midshipmen and cadet engineers departed separately from Annapolis for their summer cruises aboard the academy’s practice ships.

In June the cadet midshipmen boarded U.S.S. Constellation, a sailing sloop-of-war and gunnery practice ship. Constellation proceeded north to Rhode Island, then cruised along the coast to allow the cadets practice in seamanship and navigation. The first attempt at target practice with the IX-inch gun showed that the cadets had a lot to learn: Capt. William Jeffers reported that the rate of fire was extremely slow, and the

Academical Year 1870-71 (Troy, NY: Wm. H. Young and Blake: 1871). None of the 1871 cadet engineers appears in the RPI Register index of graduates or in the Harvard records.

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shots were inaccurate. With practice, the cadets’ aim and rapidity of fire improved over the duration of the cruise. Jeffers lamented that there was no rough weather during the summer; he felt that the smooth seas did not test the seamanship of the cadets.\footnote{Annual Register of USNA 1872-73. pp. 28-29}

While Constellation cruised off New England, the cadet engineers shipped out for a cruise on the practice steamer Tallapoosa. Unlike the midshipmen, the cadet engineers did not have to go aloft in the rigging or stand watches on the deck. Instead, their watches were in the engine room and fire room. They learned to perform all starting and stopping of the engines, to attend the oiling of the machinery, and to manage the fires under the boilers. They also took measurements of steam saturation and recorded cylinder pressures with indicator diagrams.\footnote{William Jeffers, “Report of Practice-Cruise, Constellation” in Annual Report of the Secretary of the Navy on the operations of the Department for the Year 1872 (Washington, D.C.: Government Printing Office, 1872), pp. 36-38.} By the end of the cruise, the men were proficient at watch standing in the machinery spaces.

Practical engineering exercises aboard Tallapoosa were only part of the engineers’ summertime education. The ship put in to several ports along the coast, particularly in manufacturing cities. In Philadelphia, the cadet engineers toured the shipbuilding works of Cramp and Son, and the shops of I.P. Morris & Co. At those facilities they witnessed construction of iron hulls and steam engines and were introduced to the firms’ owners, managers, and foremen.\footnote{John C. Kafer and Charles Manning, “Report of Practice Cruise, Steamer Tallapoosa,” in Report of Secretary of the Navy 1872, p. 40.} Tallapoosa made calls at the Navy yards in Washington, Norfolk, Philadelphia, Boston, and Portsmouth, New Hampshire. The cadets examined the machinery of the ships present at each yard, while their instructors explained the advantages and

\footnote{Kafer and Manning, “Report,” pp. 41-42.}
disadvantages of the various engine types powering the vessels. Tours of the workshops on each base provided the engineers with greater understanding of the construction processes for machinery components. They spent a few days in the foundry at Portsmouth, where the master molder taught them how to mix metal alloys and cast brass and iron parts. Experiences during the summer cruise allowed the cadet engineers to connect their theoretical training with practical skills.

When the cruise finished late in the summer, the cadet engineers returned to Annapolis. They resumed their class work in the autumn. This was the final group of engineers that passed through the Academy's two-year program, so they entered their final year of school and most advanced classes. The cadet engineers took up calculus, thermodynamics, hydrodynamics, and electricity. Extensions of their practical exercises with the steam machinery and mechanical drawing filled more hours. The demands were heavy, and most of the cadet engineers were not up to the task. Only five men were prepared to graduate in 1873; three were dropped from the rolls after failing their re-examinations, and eight had been turned back for another year of study.\[12\]

The cadets' inability to handle their studies – particularly mathematics – did not go unnoticed. In 1872 the twelve-member Naval Academy Board of Visitors thought the Navy should provide a better foundation in science and math. The report for the year argued, "The rapid advance of science...demand for our naval officers higher attainments in mechanics, physics, and chemistry than were formerly necessary." The Board suggested more instruction in thermodynamics, mechanics, physics, and astronomy. The 1872 Visitors included two Army officers: Major-General J.C. Robinson and Colonel

\[11\] Kafer and Manning, "Report," pp. 41-42.
William Bartlett, who was also a professor at West Point. Army pedagogical influence was evident in their conviction that “a liberal mathematical training is now come to be justly regarded as the proper groundwork of a young naval officer’s education.” Change did not follow immediately; the Board of Visitors in 1873 also urged the Academy to increase science and engineering education.

Administrators at the Academy took these suggestions to heart. After 1873 the amount of mathematics in the cadet engineers’ course increased, as did the proportion of mechanics, physics, and chemistry. The following year the engineer program was extended to four years, to allow enough time for the men to be trained effectively for their field.14

Annapolis attracted growing numbers of applicants to the engineering program. One Navy engineer listed his motivations for entering the naval engineering service: patriotism and a desire to serve the government, a yen for scientific training, and an engineering instinct.15 Between fifty and one hundred men applied annually for approximately twenty positions. Among the ranks of the entering class of 1873 was a member of an elite American engineering family, Edmund Roebling. The cadet engineer was the son of famed bridge builder John Roebling. Edmund’s older brother, Washington, attended the engineering program at RPI in the 1850s. Perhaps the Roebling family believed that in 1873, Annapolis offered a better engineering education than

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Rensselaer, and arranged for Edmund’s admission to the academy. Another possibility is that Edmund lacked maturity and self-discipline, and his father hoped a military education would instill these qualities in his son. Whatever the case, the young Roebling failed to deliver. He was dismissed in March 1873 for leaving the academy grounds without permission, in direct violation of regulations.\textsuperscript{16} Discipline problems at the Academy were no longer tolerated.

\textbf{Discipline and Race Relations}

Strict discipline was employed in one case involving a Cadet Engineer. In 1874, Maryland native Gordon H. Claude was dismissed from the Academy after refusing to take part in fencing exercises. Claude’s problem was not with the exercise; it was with his opponent. Claude was ordered to fence with another cadet, a man simply described by a witness as “the nigger.” Claude disobeyed. This misconduct was reported to the Navy Department, and the Cadet Engineer was forced to resign from Annapolis. The other Cadet Engineers were incensed at the Department’s action, and threatened the life of Claude’s opponent. One wrote home, “[Claude’s dismissal] is looked on as a regular gouge. I am not sure but [the nigger] may find himself over the sea wall and floating out to sea some night. Can’t most always tell what will happen…”\textsuperscript{17}

\textsuperscript{16} Numbers of applicants compiled from \textit{Report of the Secretary of the Navy 1872-1883}; Letter, “George Robeson to Cadet Engineer E. Roebling,” (27 March 1873) USNA Archives Record Group 405 Office of the Superintendent - Administrative Records Relating to Midshipmen and Cadets, 1846-1925. Letters and Reports Received by the Superintendent Relating to Individual Midshipmen, 1846-1888 Box 6 Folder 4. \textsuperscript{17} Letter, “Mortimer E. Cooley to Orwin,” (27 February 1875) in Box 1: Correspondence 1873-1887, and Undated; Folder: Mortimer E. Cooley, General 1875. Mortimer E. Cooley Papers, Bentley Historical Library, University of Michigan. Hereafter cited as ‘Cooley Papers.’ Claude either resigned or was dismissed; in the \textit{Annual Register of the Naval Academy}, both reasons are listed. He probably resigned under threat of dismissal.
If Claude's opponent was indeed African-American, no mention of him exists in the published histories of the Academy. Annapolis' first black midshipman, James H. Conyers, was admitted from South Carolina in 1872. He was found deficient in mathematics and French after one year at Annapolis, and resigned on November 11, 1873.\textsuperscript{18} This was months before Claude arrived at the Academy, so it is impossible that this was the black midshipman involved in the fencing incident.

Without indication of another black cadet at the Academy, some other explanation must be found. One possibility is that Claude believed one of his fellow cadet engineers was of African descent. Perhaps Alberto de Ruiz, born in Cuba, was dark-completed and therefore viewed by his classmates as inferior. de Ruiz had a checkered career at the Academy. He entered initially in 1871, but was found deficient and recommended for discharge at the end of his first year. Instead, he was turned back to the second class. In 1873 he was again found deficient and recommended for discharge, and his name was entered on the list of men who resigned. Somehow he returned again, and in the 1875-76 academic year, he finally made it to the bottom of the merit roll of the first class. Though an entry does not appear in the Academy register, de Ruiz apparently graduated in 1875. He later performed duty aboard U.S.S. Marion, ultimately resigning in 1885.\textsuperscript{19}

de Ruiz was not the only foreign-born cadet at Annapolis in the 1870s. Under an 1868 law, the government of Japan was allowed to assign up to six students to study at

\textsuperscript{18} Annual Register of the Naval Academy 1872-73, p. 20; Annual Register of the Naval Academy 1873, p. 15.

\textsuperscript{19} Annual Register of the Naval Academy 1871-72, p. 39; Annual Register of the Naval Academy 1872-73, p. 41; Annual Register of the Naval Academy 1873, pp. 21, 26; Annual Register of the Naval Academy 1874-75, p. 25; Annual Register of the Naval Academy 1875-76, p. 37; Register of the Commissioned, Warrant, and Volunteer Officers of the Navy of the United States, Including Officers of the Marine Corps and Others, to January 1, 1877 (Washington, D.C.: Government Printing Office, 1877), p. 69; Bennett, Steam Navy, Appendix A.
the U.S. Naval Academy. The first two Japanese cadets arrived in 1869, and over the next decade another ten Japanese men came to Annapolis. In 1878 Sadanori Youchi enrolled in the engineering program; the rest of his countrymen at the Academy were members of the cadet midshipmen brigade. Details of their post-Annapolis careers await research; tantalizingly, some of them played critical roles in the Russo-Japanese War. Annapolis graduate Sotokichi Uriu became a Rear Admiral in the Imperial Japanese fleet. At the 1904 Battle of Tsushima Straight in the Russo-Japanese War, he commanded the Fourth Destroyer Division from his flagship, *Naniwa*. Another U.S. Naval Academy cadet from Japan, Kantaro Arima, became Admiral Togo’s Flag Commander in that war.

Annapolis’ Unique Engineering Curriculum

By 1876 the Academy had refined its science and engineering curricula enough so that they subsequently changed very little. In that year, cadets studied physics with a notable instructor, Albert Michelson, the first American to win a Nobel Prize. Michelson, or “Mike,” as he was known to his fellow officers, was a product of the Naval Academy. He won an appointment at large from President Grant in 1869, partly for political reasons; the general wanted to gain the support of Jewish voters. As a cadet midshipman, Michelson’s passion and aptitude centered on science, particularly physics. Throughout his cadet career at the academy, he was among the top students. In classes in optics and acoustics, thermodynamics, and steam engineering he stood out. His abilities in optics

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created a stir among the faculty, and following his post-graduation cruise he was appointed instructor in physics and chemistry at the academy. While teaching at Annapolis in 1879 he devised his first experiment and apparatus to measure the speed of light.²² As early as the 1870s, the Navy reaped the benefits of post-war scientific training at its professional school.

![Image of Albert Einstein and others](image)

Figure 22 – Albert Michelson, Albert Einstein, and Robert Milliken in 1931. Einstein said of Michelson’s speed of light measurements, "...your marvelous experimental work paved the way for the development of the theory of relativity...." Source: Publications of the Michelson Museum No. 3, pp. 28-29.


Dorothy M. Livingston is Albert A. Michelson’s daughter. Her work displays the usual strengths and weaknesses of family-written biographies: intimate detail, but also an element of hero worship.
The cadet engineers’ mathematics load stabilized with two years of foundation classes in algebra, geometry, and trigonometry. In year three they took up calculus; an additional, elective course in calculus was offered to those showing the most aptitude in the subject. The best students of the midshipmen and engineers corps invariably enrolled in the difficult elective classes. For the cadet engineers, engineering classes included the fabrication, design, and drawing of machinery; this was combined with theoretical and practical exercises with marine engines. In the Department of Physics and Chemistry, the engineering students studied acoustics, optics, electricity and magnetism, and general chemistry. Thermodynamics occupied the primary science slot in their final year.\textsuperscript{23}

The training imparted to the cadet engineers made an indelible impression. 1878 Annapolis graduate Mortimer Cooley reflected on his Navy experience later in life. “Let me say a word about the old engineering course at the Naval Academy,” he wrote to the Secretary of the Navy. “In its day it was the finest course in mechanical engineering offered anywhere. The men turned out had fundamentals driven home with a triphammer. Cadets took their education like quinine off a knife blade -- not in capsules to hide the taste.”\textsuperscript{24}

Fundamental and theoretical training in mathematics and sciences were important, but institutions such as RPI offered similar training. The Annapolis form of engineering education differed in its emphasis on practical application of that knowledge. By 1877 the head of the Steam Engineering Department was convinced Annapolis outstripped any other institution in its method of combining theory with practice. The Academy’s

\textsuperscript{23} Annual Register of the United States Naval Academy, Annapolis, MD. Twenty-seventh Academic Year, 1876-77 (Washington, D.C.: Government Printing Office, 1876), pp. 55-61.
experimental equipment and working engines provided opportunities to reinforce the lessons imparted in theory-based classes. The department head averred "...the facilities for this sort of instruction being quite unrivaled in technological schools." Annapolis' classes and laboratories melded practice and theory, but the training extended beyond the walls of the academy.

At Annapolis, daily recitations and practical exercises stressed the importance of applying knowledge to real-world problems. Images of Annapolis classrooms and laboratories in the 1870s provide a window on that pedagogical approach.

Figure 23 - An engineering classroom at the U.S. Naval Academy during the 1870s. Source: USNA Archives.

The engineering classroom depicted in Figure 23 illustrates the Annapolis approach to technical education. At the most basic level, desks appear on the far left and in the center of the frame. Instructors occasionally lectured to the cadets, conveying information through that traditional method. However, the classroom was more of a laboratory than a lecture hall. Sixty years after graduating, Cooley remembered the trials of his education at Annapolis. “It could not be said that we were taught at all. We had to learn everything by ourselves...the result developed self-reliance and produced men who were fearless in the face of problems which had not been solved before.”

Another engineer similarly recalled, “the studies were severe with lessons long and examinations searching. It was fine training.”

The laboratory depicted in Figure 23 illustrates some of the teaching tools used by the Academy’s instructors and cadets. Prominently displayed throughout the room are models of steam engines and propulsive machinery. Miniature machinery gave the cadets a view of the equipment impossible to garner with full-sized gear. Marine steam engines of the time could be fifty feet long or more, and stand twenty feet high. By teaching the cadets on models, they were able to see the engine in its entirety. As importantly for their development, engineers could tower over the engine in the classroom. This gave them a sense of authority over the machinery.

The image also shows blackboards ringing the room. Instructors required the cadets to work mathematical and design problems together on the boards during recitations. Exam questions, too, were worked on the boards. Under pressure to perform

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26 Cooley, Scientific Blacksmith, pp. 44-45.
during the exams and in full view of their peers, instructors, and sometimes the Board of Visitors, cadet engineers had to develop solutions to the problems presented. As Cooley attested, this method of teaching produced in the cadets self-confidence in their ability to handle themselves in stressful situations.

Additional aspects of cadets’ training are visible in Figure 23. Cadets often drew data for the calculations from experimental equipment. On the center table in the photograph, apparatus fitted with various gauges monitor pressures in the experimental system. Behind the piece diagrams on a blackboard graphically represent the pressure curves registered by the gauges. Tools rest on hooks above workbenches in the right center background, used to work on the classroom’s model engines. Cadet Engineers trained not only to design machinery, but also for practical engine driving tasks in the fleet. Aboard ship, they needed the hands-on experience of operating and repairing engines.

Instructors at the Academy instilled practical skills in the laboratory and during the increasingly important summer practice cruises. The summer practice cruises were equally important for the development of Annapolis’ unique engineering pedagogy. Practical experience in the engines rooms of the practice steamers drove home critical design lessons. The engineers lived with and worked on the engines they designed. Like Benjamin Isherwood, Annapolis-trained engineer understood the theory behind their designs, but also possessed a hands-on familiarity that tailored their engines to the tasks required.

The practice cruises also strengthened the links between government and industry. The 1872 cruise set a precedent for visits to Navy yard shops and private manufacturing
facilities. In succeeding years, cadet engineers toured more facilities. They observed and participated in a wider variety of practical skills. In July 1873 the cadet engineers departed from Annapolis aboard the practice ship *Fortune*. The vessel proceeded to Wilmington, Delaware so the cadets could tour the works of several companies in the area. As a courtesy, the owner of Jackson, Sharp, and Co. allowed *Fortune* to tie up at his wharf free of charge. The next day, the cadet engineers toured the iron foundry of E.C. Stottzenberger and Son. The owner of the company spent three hours with the group, explaining the processes for making cast iron castings of different grades of hardness. Next the group visited the engine and ship building works of Pusey, Jones and Co. The men observed the fitting up of a marine steam engine, and inspected a large iron vessel on the launching ways.\(^{28}\)

The inspection tours continued for the remainder of the cruise. Senior members of each company accompanied the cadets through each site, and the cadets absorbed an enormous amount of information. Still in the Wilmington area, the plate-iron rolling mills of Slidell and Hastings provided opportunity to learn about metallurgy, and the cadets took pages of notes and made drawings of the equipment at the works. At Harlan, Hollingsworth and Co., the cadets broke into groups and dispersed through the various departments. Each cadet was assigned components of engines and ship systems to sketch and describe in his journal.\(^{29}\)

From Delaware the ship sailed to Chester, Pennsylvania so the cadets could examine the yard of Roach and Son. The superintendent of the company, Mr. Boole, put


\(^{29}\) McCormick, "Report," p. 49.
aside his work for several days in order to guide the cadets personally through the company. Roach and Son had eleven iron ships building that summer, and the students toured all of them. Fortune’s commanding officer, Lt. Cmrd. Alexander McCormick, found the company so obliging that he decided to remain at Roach and Son for nine days. The cadet engineers studied iron shipbuilding and the design and construction of marine steam engines, and McCormick reported that the entire time was devoted to instruction “with very great profit” to the cadets.\(^{30}\)

This pattern of teaching the cadet engineers at private establishments continued through the summer. Other facilities visited in 1873 included the Morgan Iron Works, West Point Foundry, Bay State Iron Works, Norway Iron Works, the smelting furnaces of Brock & Co., and all of the Navy yards along the coast.\(^{31}\)

In later years, the commanding officers of the practice ships expanded the tours. All of the important engine and ship building yards of the east coast contributed to the education of the cadet engineers: Baldwin Locomotive Works, William Sellers & Co., Delamater Iron Works, Merrill & Sons, Corliss Steam Engine Works, Providence Steam Engine Co., and others. In 1877 the commander of the practice ship Mayflower commended the proprietors of all these firms. “At all the establishments visited,” he noted with satisfaction, “the cadets have been received with uniform kindness, and every facility for their instruction placed at their disposal.” Commander Sampson added that many companies went an extra mile for the Navy cadets: “In many cases their visit was anticipated, and special machinery set in motion, or interesting processes exhibited which they might not otherwise have understood.”


American heavy industry went out of its way to accommodate the Navy and its engineering students in the 1870s. Many of the companies visited during the practice cruises had long-established relationships with the Navy; they had built engines and vessels for the Union in the Civil War, or even earlier. Managers and owners of the firms might have perceived commercial gain in the tours. Their hospitality built personal relationships with engineers, and that might be rewarded in the future when the government issued Navy contracts. In addition, the firms were able to meet the nation’s most able young engineers; a certain amount of recruiting of those talented men might have been in the minds of the proprietors. At least one Navy engineer ended up working for a firm visited during the practice cruises. In 1889 the Morgan Iron Works hired former Navy engineer John C. Kafer as superintendent. He later served as secretary, treasurer, and vice president of the company.32

End of the Engineering Program

Through the late 1870s, the line and engineering curricula at Annapolis converged. By the 1879-1880 academic year, the differences in instruction between the two groups were extremely limited. Cadet engineers were excluded from studies in seamanship, naval tactics, and gunnery. They were not required to enroll in navigation or surveying, but their other classes prepared them for these tasks. Every other subject studied by their line counterparts was also included in the engineers’ curriculum. Conversely, the cadet midshipmen did not undertake classes in the design and fabrication

of machinery, strength of materials, or naval architecture. They also did not have to take a laboratory class in physical measurements.\textsuperscript{33}

The only differences in the first two years of instruction for the two corps was the substitution of steam engineering for seamanship in the engineers' course. In the third year, the only divergence was steam engineering in lieu of seamanship, ordnance, and navigation. Cadets' final year saw engineers study mechanics and applied mathematics, while the midshipmen continued ordnance and navigation. Both groups studied seamanship and steam engineering as First Class cadets.\textsuperscript{34}

While the steady unification of the two corps continued at the Academy through the decade, the engineering program became a victim of its own success. By the late 1870s, most cadet engineers who entered the academy were able to complete their studies. Within a few years, the number of engineering graduates emanating from Annapolis overwhelmed the number of commissions allowed by law. Partly this was because the course of instruction was better organized, and engineers failed or "bilged" out of the academy less frequently. Another factor was that the caliber of student increased. The Navy engineering program developed a reputation for excellence, and the pool of applicants expanded. In 1880, one hundred sixty-seven men reported to Annapolis for the engineering course's competitive entrance exam; this was more than three times the number that sought admittance in 1871. Only sixty-six men presented

\textsuperscript{33} Annual Register USNA 1879-80, pp. 61-65.
\textsuperscript{34} Annual Register USNA 1879-80, pp. 66-67.
themselves for the cadet midshipman exam, and forty-two received appointments.\textsuperscript{35} 

Competition to become a cadet engineer was sharper than that for cadet midshipmen.

The upshot of this success was that each year, an average of twenty-three new engineers entered the fleet. Chief of the Bureau of Steam Engineering William Shock claimed that this was necessary to fill vacancies in the lowest engineering rank, Assistant Engineer. Conversely, line officers insisted that this created a glut of engineers. In 1877 academy superintendent C.R.P. Rodgers reported that the numbers of both cadet midshipmen and cadet engineers should be decreased. Rodgers recommended hiring an actuary “to calculate the annual waste of the Navy of both the line and the engineer corps; and...how many cadets should each year enter second class to supply that waste, and keep the number of officers in the lower commissioned ranks...always full.”\textsuperscript{36} Rodgers and Shock represented the line and engineers, respectively. At heart, each man had the interests of his own corps as he saw it. Whose assessment was correct?

The Navy Registers offer data to support Shock. Legislation of 1871 set the number of engineers at a total of 270: 70 chief engineers, 100 First Assistant Engineers, and 100 Second Assistant Engineers. In 1874, another law changed the titles of the junior grades to Passed Assistant Engineer and Assistant Engineer. The Navy Registers show that from 1874 to 1877 there was an average of six vacancies in the rank of Passed Assistant Engineer, and an average of fifty-four vacancies in the rank of Assistant


Engineer. The Academy’s engineering graduates should have been promoted to fill the available Assistant Engineer billets, but they were prevented from doing so. The numbers of graduated Cadet Engineers grew through the decade, with the men hanging in naval limbo waiting for their commissions.

<table>
<thead>
<tr>
<th>Date</th>
<th>Chief Engineer (70 allowed)</th>
<th>Passed Ass’t. Engineer (100 allowed)</th>
<th>Assistant Engineer (100 allowed)</th>
<th>Graduated Cadet Eng.</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1872</td>
<td>62</td>
<td>94</td>
<td>85</td>
<td>-</td>
</tr>
<tr>
<td>January 1873</td>
<td>62</td>
<td>97</td>
<td>75</td>
<td>-</td>
</tr>
<tr>
<td>January 1874</td>
<td>66</td>
<td>91</td>
<td>54</td>
<td>5</td>
</tr>
<tr>
<td>January 1875</td>
<td>67</td>
<td>92</td>
<td>42</td>
<td>10</td>
</tr>
<tr>
<td>January 1876</td>
<td>70</td>
<td>93</td>
<td>47</td>
<td>16</td>
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<tr>
<td>January 1877</td>
<td>70</td>
<td>97</td>
<td>41</td>
<td>19</td>
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<tr>
<td>July 1878</td>
<td>70</td>
<td>96</td>
<td>38</td>
<td>28</td>
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<tr>
<td>January 1879</td>
<td>70</td>
<td>96</td>
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<td>January 1881</td>
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<td>100</td>
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<td>53</td>
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<tr>
<td>January 1882</td>
<td>70</td>
<td>100</td>
<td>63</td>
<td>40</td>
</tr>
<tr>
<td>July 1882</td>
<td>70</td>
<td>99</td>
<td>62</td>
<td>62</td>
</tr>
</tbody>
</table>

Figure 24 – Ranks of engineer corps, U.S. Navy 1872-1882. Legislation of 1873 set the number of Chief Engineers at 70, Passed Assistant Engineers at 100, and Assistant Engineers at 100. Though an average of 48 vacancies existed in the lowest engineering rank, many graduated Cadet Engineers did not receive orders to sit for their promotion examination for years, and stagnated as warrant officers awaiting their commissions.


The year 1882 was particularly bad for the engineers of the Navy. Two laws diminished their standing. The first reduced the numbers of Passed Assistants and Assistants to 60 and 40, respectively. The second law abolished the separate engineering program at Annapolis. The law also mandated that men would only be drawn from the

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graduating classes to fill vacancies in the engineers’ corps. Any surplus graduates would be given a year’s pay and an honorable discharge.\textsuperscript{38}

The effects were immediate. When the engineer class of 1881 returned from its sea duty, most of its members were dismissed from the service. Only the top engineer was commissioned; all others were honorably discharged.\textsuperscript{39} The naval career path for these elite engineers closed, and they were forced to ply their talents in the civilian world.

\textbf{Conclusion}

The Naval Academy in the 1870s refined its technical and scientific curricula and steadily incorporated engineering classes into the training of its line officers. By the end of the decade, the line and engineering courses were so similar that pedagogically, they could be merged. Engineers claimed that the amalgamation resulted in less competent officers, since the depth of engineering knowledge imparted after 1882 was not as great as before.

This was probably true, but it was also a reaction to the social and professional difficulties faced by the engineers after amalgamation. The cadet engineering graduates were thrown from their naval career paths when 1882 legislation reduced the size of their corps. In response, several of the displaced men turned to industry. An example is Oliver B. Shallenberger; left without a naval career upon graduation, he accepted a job with the Westinghouse Electric Company.\textsuperscript{40}

Other engineers chose a different method of finding employment. In 1879, just before the merging of the line and engineer courses, Navy engineers shepherded their

\textsuperscript{38} Bennett, \textit{Steam Navy}, pp. 675, 751.

\textsuperscript{39} \textit{Annual Register USNA 1883-84}, pp. 38-40.
own legislation through Congress. Under that law, active duty engineers could be detailed to technical schools and universities to help foster engineering education. A few dozen engineers accepted positions at American universities, and transferred the Navy style of engineering education to the rest of the country.

Chapter Nine – Navy Engineers in Academia

Introduction

In the 1870s, Annapolis engineering graduates possessed a unique education. Upon a foundation of science and mathematics, they built experience in practical design and operation of machinery. Their grasp of the theoretical underpinnings of their field placed them at the forefront of mechanical engineering in America. These men were primed for technical careers.

However, Navy career prospects were dim for young engineering officers. The number of ships in the fleet declined, reducing the availability of billets for all officers. Older line officers claimed that the Academy produced an overabundance of engineers, and recommended cutting their numbers. The line convinced Congress to pass anti-engineer legislation. These actions caused the line-staff controversy to flare again, and the rivalry continued to fester throughout the end of the century. The 1882 Naval Academy amalgamation of midshipmen and engineers could have been the foundation for a unified corps of officers. However, it failed to alleviate tension among junior officers, and the prejudices of senior men remained virulent.

The engineers responded in a variety of ways. Some of them persevered in the Navy. Others left the service to join industry. Most significantly, a group of officers advocated for legislation that allowed them to become professors at civilian universities. The men so detailed over the next decade were responsible for transferring the Naval Academy engineering pedagogy to the nation.
Navy Engineers as Educators

In 1878, engineers in the Bureau of Steam Engineering responded to shrinking prospects in the fleet by summoning support in Congress. They drafted a short bill, called "An act to promote the knowledge of steam engineering and iron ship-building among the scientific schools or colleges of America." The bill proposed that up to twenty-five officers be posted annually as engineering instructors to technical schools, and it was passed into law in February, 1879.¹

The bill’s Navy proponents followed the lead of a few engineers who had already left the service for academia. The best-known example among these men was Robert Thurston. As a result of the turmoil instigated by Porter in the late 1860s, First Assistant Engineer Thurston vacated his position at the Academy as Assistant Instructor in Natural and Experimental Philosophy. He resigned in 1871 to assume an engineering professorship at the newly-founded Stevens Institute of Technology in Hoboken, New Jersey. After fourteen years at Hoboken, Thurston moved to Cornell University in 1885.²

Thurston was not the only Navy veteran professor in the 1870s. Charles Bray, the top graduate among the 1868 Annapolis Acting Third Assistant Engineers, became a professor after he quickly lost his desire to serve in the fleet. His resignation was partly a result of his billet to the Pacific Squadron in U.S.S. Mohongo, a Civil War vessel designed for river duty. Even the ship’s commanding officer found the ship unsuited for cruising in the Pacific, and with Porter’s General Order 131 limiting the ship to sail only,

¹ Bennett, Steam Navy, p. 732.
the engineers aboard grew dissatisfied. Bray resigned in March 1869 after enduring a single cruise, and returned to his native New England to get married.

Soon after his arrival in Massachusetts, Bray accepted the offer of a professorship at Tufts College in Medford, Massachusetts. The college was founded in 1852, and the engineering program was added in 1866. Bray was responsible for nurturing the small school's nascent civil and mechanical engineering program.4

The curriculum Bray established closely resembled that of Annapolis. He increased the proportion of mathematics in the Tufts engineering course, beginning with trigonometry and descriptive and analytical geometry in the first and second terms. These were the same subjects taught to Navy Cadet Engineers in their first two terms at the Academy. The students at each institution read some of the same texts, including Rankine's work on engineering. The new professor implemented third and fourth semester classes in differential and integral calculus; Navy cadets also undertook these studies in their second year. Engineering pupils at the Naval Academy applied themselves to physics, chemistry, and mechanical drawing as part of their Naval Engineering course. Their counterparts at Tufts also pursued these subjects.5

Tufts engineering education differed from that of Annapolis in two fundamental ways. First, students at Tufts received a solid liberal arts background, encompassing such diverse topics as Mineralogy, Botany, Political Economy, and Lectures on Christian Evidences. The Cadet Engineers at the Academy pursued only engineering. They focused

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5 "Engineering Course," A Catalogue of the Officers and Students of Tufts College, 1869-70 (Boston: John S. Spooner, 1870), pp. 16-17; Annual Register of the USNA, 1868-69, p. 43.
exclusively on technical subjects including Iron Ship-building and Management of Machinery. This last section consisted of practical exercises with steam engines and boilers, experience vital to the engine-driving roles they would fulfill as Third and Second Assistant Engineers aboard ship.⁶

Bray's second curriculum divergence from Navy education came at the expense of practical exercises. The financial resources of the college were limited, and during the early years of Bray’s tenure the mechanical engineering department owned no steam engine. Thus prevented from experimentation and hands-on experience with machinery, he nonetheless strove to incorporate practical education in his teaching. He required all of his mechanical engineering students to design and draught a complete steam engine, ensuring they could comprehend the spatial relationships necessary to its functions.

Copying the experiences of Annapolis practice cruises, the professor arranged visits to industrial plants and manufacturing establishments in order to bolster his students' practical knowledge base. In 1871 he was granted permission by the college to instruct his students off campus for a month; his civil engineers-in-training surveyed and constructed a portion of railroad bed. The Navy cemented in its mechanical engineers a philosophy of practical application of theory. This educational vision transferred to Bray and ultimately prevailed at Tufts later in the decade when he convinced the college to acquire an experimental steam engine for his students.⁷

In the course of thirty-eight years of teaching, Bray watched four hundred eighty-eight of his charges graduate. Despite graduating from a little-known school, Tufts

⁶ A Catalogue of Tufts College, 1869-70, pp. 16-17; Annual Register USNA, 1868-69, p. 43; Annual Register USNA, 1871-72.
engineering graduates dispersed throughout the world and pursued a terrific range of professional duties. A few worked as mining engineers for companies in the American West. One became president of the Midvale Coal and Coke Company. Tufts alumni were the city engineers of Camden, New Jersey, and Hattiesburg and Kansas City, Missouri. Railroads felt the influence of Charles Bray’s students; in Massachusetts the State Engineer for Grade Crossings earned two engineering degrees at Tufts. The Second Vice President of the Chicago, Rock Island and Pacific Railroad studied under Bray, as did the Chief Engineer for the Lehigh and New England Railroad.8

Some of the professor’s engineers worked for navy contractors. The district sales manager for the Ridgway Dynamo and Engine Company’s Chicago branch was educated at Tufts; among other products the company supplied engines for World War I-vintage American submarines. Westinghouse Electric and Manufacturing Company, Pratt and Whitney, General Electric, and Edison Electric all employed former students of Charles Bray.9

The professor dedicated his entire working life to the education of a new generation of engineers. The knowledge and training that the former Navy engineer imparted to these men rippled through American industry at the turn of the century. In recognition of his contributions to engineering and the college, Tufts granted him Professor Emeritus status in 1908. He continued to live on campus at Tufts until his death

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8 *Tufts College Register of Officers of Instruction and Government and Directory of Graduates* Vol. XII No. 4 (Tufts College, Massachusetts: 1912), pp. iv, 35-52
in 1920. Bray did not recede from the college's collective memory: in 1947, Tufts new mechanical engineering building was named in his honor.\(^{10}\)

**Active-duty Instructor Details**

Of greater moment than the work performed by Bray were the several details of active-duty Navy engineers to universities. The 1879 law sent men across the country. The first school to receive a Navy engineer was Lafayette College in Easton, Pennsylvania. Walter Worthington (USNA 1875) reported to Lafayette in 1879, and spent two years at the institution. As his duty came to a close in the summer of 1881, the Navy instructor program gained momentum through four additional details. The Navy ordered Henry Spangler (USNA 1878) to the University of Pennsylvania. Union College in Schenectady, New York received Ira Hollis, the top graduate of the class of 1878. George Willits (USNA 1875) arrived at the Franklin Institute in Philadelphia. The final instructor assignment for the year was Assistant Engineer Mortimer Cooley (USNA 1878), sent to the University of Michigan.\(^{11}\) The Navy after 1881 made an enormous impact on the development of American mechanical engineering practice.

Mortimer Cooley's path to the private sector was similar to many of his fellow engineering officers. He rapidly became disenchanted with the Navy after graduating from Annapolis, partly due to the Navy's delay in granting his commission. Cooley complained in 1881 that his promotion examination was a year overdue. The added

\(^{10}\) "Dedication Exercises: Bray Memorial Laboratory of Mechanical Engineering, June 14, 1947," copy of dedication schedule held in Tufts Archives.

\(^{11}\) *Navy Register 1881*, p. 68; *Annual Register USNA 1875-76*, p. 37; *Navy Register 1882*, pp. 72-74; *Annual Register USNA 1878-79*, p. 25, Bennett, *Steam Navy*, pp. 733.
prestige of being a commissioned officer was surely one reason Cooley desired the promotion, but there were 700 other reasons. As a graduated Cadet Engineer, Cooley’s sea-duty salary was $1000; after his promotion to Assistant Engineer, the salary would increase to $1700. The engineer was married soon after graduation, and his wife gave birth to a daughter during the engineer’s second post-graduate cruise in 1880. Supporting a family on $1000 per year was hard to do, and it became even more difficult when he was detached from his ship and ordered to the Bureau of Steam Engineering. Cooley’s
shore duty pay was only $800 as a Cadet Engineer, but would be $1400 once his commission came through.\(^\text{12}\)

In May 1881, Cooley finally received orders to report for his promotion examination in Philadelphia. He passed handily, and returned to Washington. His commission followed in June, finding him engaged in shore duty at the Bureau. His work there was not related to engineering, however; he spent the hot summer months reorganizing the department’s old personnel records. Writing to his brother, Lyman Cooley, he tried to put a brave face on his dissatisfaction, “It is not the duty I wish, but until I secure that, of course I can or ought to rest satisfied with what is given me. I am no better pleased with the service than ever, but the favorable day for resigning has not yet come.”\(^\text{13}\)

The assignment Cooley wished for was an expected transfer to the Bureau of Steam Engineering’s drafting room, where he could practice the skills honed at the Academy. Instead, Admiral Porter interceded and ordered him to assist the Bureau of Ordnance in casting a statue of Admiral Farragut.\(^\text{14}\) In response to this disappointment, Cooley sought better duty away from Washington and the fleet: a billet at a college under the 1879 law.

In July 1881, Cooley’s brother, Lyman, wrote to Professor Charles Greene at University of Michigan, explaining to him the “red-tape of the method” to win the

\(^{12}\) Letter, “Mortimer Cooley to Lyman Cooley,” (13 April 1881) Box 1 – Correspondence, 1873-1887, and undated, Folder – General, 1881, Cooley Papers; Cooley, *Scientific Blacksmith*, pp. 52-56; pay figures from *Navy Register* 1880, p. 3.


\(^{14}\) Letter, “M. Cooley to L. Cooley,” (16 April 1881); Order, “Admiral David D. Porter to Cadet Engineer Mortimer Cooley,” (16 April 1881, forwarded 18 April 1881) Box 1, Folder – General 1881, Cooley Papers.
assignment for Mortimer. Greene was to convince the university president to write a letter to Secretary of the Navy William Hunt, who would refer the matter to William Shock, Chief of the Bureau of Steam Engineering. If all went well, Shock would then order an engineer to the university. Cooley told Greene that a particular officer could be requested for the detail, and that he hoped his brother would be favorably considered.\textsuperscript{15}

In less than one month, the matter was settled. Cooley received orders from Secretary Hunt, detaching him from the Bureau of Steam Engineering and sending him to Ann Arbor. Immediately, Michigan's acting president, Henry Frieze, wrote an excited letter to the engineer. Frieze felt Cooley's presence was "of vital importance to the successful opening of the new course of engineering study." The university already had small programs in Civil and Mining Engineers; a new course in Mechanical would complete the Engineering school.\textsuperscript{16} The university president informed Cooley that all studies in Mechanical, Steam, and Ship Building Engineering would be under the Navy man's personal direction. Cooley was charged with laying out and organizing the plan of classes, the selection of all textbooks, and establishing requisite shops for practical work. He would be responsible for creating a new academic program.

The opportunity spread before Cooley must have been exciting, but daunting. From the University of Pennsylvania, Henry Spangler informed Cooley that the task at Michigan was "too much work entirely for any one man." However, Cooley was not

\textsuperscript{15} Letter, "L. Cooley to Charles Greene," (5 July 1881) Box 1, Folder – General 1881, Cooley Papers.
\textsuperscript{16} Order, "William Hunt to Mortimer Cooley," (2 August 1881); Letter, "Frieze to Cooley," (4 August 1881): Box 1, Folder – General 1881, Cooley Papers
completely alone; he was connected to a wide network of competent men: his friends in the Navy engineer corps.\footnote{Letter, "Harry Spangler to Mortimer Cooley," (21 September 1881), all in Box 1 Folder – General 1881, Cooley Papers.}

Cooley solicited advice from his colleagues at both the Bureau of Steam Engineering and the Naval Academy. From the Bureau in Washington, Passed Assistant Engineer Harrie Webster provided a list of suitable articles and textbooks for the Michigan students to read. He closed his letter with encouraging words: "I shall take great pleasure in assisting you in every way possible, and I am sure Mr. Shock feels in the same way." Other engineering officers voiced similar sentiments; they, too, buttressed their good wishes with helpful material. The two longest-serving Annapolis steam engineering instructors, Passed Assistant Engineers John Kafer and Charles Manning, offered course outlines and classwork ideas for Cooley to follow. Passed Assistant Engineer Asa Mattice, described by his peers as "the smartest number of the Engineer Corps," also offered help. Mattice was busy preparing for his third year as an engineering instructor at the Academy, but promised to send copies of lectures from Annapolis.\footnote{Letter, "Harrie Webster to Mortimer Cooley," (15 August 1881); Letter, "John C. Kafer to Mortimer Cooley," (24 August 1881); Navy Register and Annual Register USNA 1867-1883; Letter, "Charles Manning to Mortimer Cooley," (15 August 1881); Letter, "Asa Mattice to Mortimer Cooley," (24 August 1881); Letter, "George McElroy to Mortimer Cooley" (13 November 1881); Letter, "Asa Mattice to Mortimer Cooley," (21 November 1881); all correspondence located in Box 1, Folder – General 1881, Cooley Papers. Asa Mattice graduated first in the class of USNA engineers in 1875.}

Cooley’s professional network extended to the men enjoying instructor details at the other schools. Henry Spangler shared his experiences at Pennsylvania with his former classmate at the start of the 1881 academic year. That school offered a diverse engineering course, with 171 students enrolled in 1882. Spangler’s position was in the special "Dynamical Engineering" branch, where Spangler joined two other engineering
professors to instruct two dozen students. In his first year as a professor, Spangler’s teaching load was limited to classes in Marine Engineering and Naval Architecture.\textsuperscript{19}

Teaching was a skill Spangler had not yet mastered. After his initial day of lecturing to the students in ship building, he dashed off a letter to Cooley. Embarrassed, he told his friend that he had made “one grand blunder,” and he hoped his letter would save Cooley from a similar mistake. Spangler had assumed his students knew more than they actually did, and the pace of his introductory lecture was far too fast. “I find my boys wonderfully ignorant,” he intimated to Cooley, then related his plan for educating the various classes of students. After lecturing on ship stability to the senior class, he planned to have them take up thermodynamics, followed by the design of ships’ machinery. The juniors would study mechanics and practical work, including two shops visits per week. The day after the shop tours, Spangler intended to lead recitation discussions of what they saw.\textsuperscript{20} The shop tours were similar to those undertaken during the Annapolis practice cruises. Spangler’s mix of theoretical instruction and practical experience at Penn directly mirrored the pedagogy of the Naval Academy.

Cooley digested all of the information and suggestions arriving in the post from his friends, then designed the new Michigan mechanical engineering curriculum. He knew that 1881-82 would be a building year, not given to convening all of the courses necessary to an aspiring mechanical engineer. The university’s course in mechanical engineering, originally codified in 1868 but dropped in 1872, had been re-instituted. It contained many of the now-standard technical foundation classes: geometry, trigonometry, calculus, and drawing. Surveying the incoming class, Cooley concluded

that they were not properly prepared for the most advanced courses he could teach: thermodynamics and naval architecture. He also concluded that due to a lack of facilities, mechanical laboratory work was out of reach for the first year.  

Cooley wanted to provide his students with practical experience as soon as possible. He drew on his own experience of Annapolis summer practice cruises and Spangler’s report of shop tours. Beginning in the winter of 1881-82 he campaigned with industries in the region, arranging visits to shops and manufacturing establishments. He also tried to make special arrangements with railroads and steamship companies to reduce the cost for students’ travel to industrial sites. Cooley asked President Frieze to send letters to transportation companies, requesting free passage for Michigan students on educational trips. Frieze honored his professor’s request, and persistence eventually resulted in reduced rates on lake steamers for student engineers.  

Industrial tours were only one aspect of Cooley’s master plan. He wanted to erect an engineering laboratory on campus for his students. Informed by the president that a $2500 state allocation was available, Cooley went to work. He contracted for the erection of a small building, then spent the remaining funds on an engine and tools for the shop. Not satisfied with the meager supply of practical instruction material afforded under the allocation, he filled his letterbook with inquiries to manufacturing establishments and machine shops around the country. Cooley asked firms to donate examples of their

products for the instruction of his students. In exchange, the professor offered to test equipment and provide assessments of the apparatus donated.²³

By the end of Cooley’s first year he had generated impressive results. Not only was the new laboratory building ready, but dozens of firms had responded to his requests with donated apparatus. From Schenectady, Westinghouse Air Brake Company sent a complete air brake outfit, valued at $500. Boston’s American Steam Gauge Company sent engine indicators and gauges; Deane Steam Pump Co. in Holyoke, Massachusetts

²³ Cooley, “Report, 1882.”
provided a steam pump in section. Several other firms made less expensive but
significant donations.\textsuperscript{24}

The largess of American manufacturing firms continued the next year. William
Sellers and Co., Nathan Manufacturing Co., and L. Schutte and Co. each shipped a
variety of locomotive injector; Henry Worthington contributed a steam water pump and
meter, worth $250. The total value of the apparatus accumulated by Cooley in his first
does years was nearly $1300. By 1884, Cooley had filled the new engineering laboratory,
and required more space. The university agreed to move the carpenters’ shop to a
position abutting the engineering lab, and convert it to Cooley’s use.\textsuperscript{25} Michigan students
learned engineering in the Navy tradition, a unique combination of theoretical and basic
scientific knowledge, and practical training in the shop.

Once Cooley’s students were adequately prepared to enter the workforce, the
professor helped them find good jobs in their field. Frequently the directors of
manufacturing firms contacted Cooley, requesting that he send capable young engineers
to them for employment. For instance, Willard Clapp, superintendent of the Detroit
Wheel Company, informed Cooley in 1887 that he was leaving his position to take a job
with another company. The Wheel Company was looking for a college-educated engineer
with practical experience to take Clapp’s place, and the directors solicited Cooley’s
advice. In an 1888 example, George Smith, president of the Middlings Purifier Company
based in Jackson, Michigan hired two skilled men for his factory at Cooley’s suggestion.
Cooley’s interest in his protégés did not end once they landed employment. After placing

\textsuperscript{24} University of Michigan Regents Proceedings 1884.
\textsuperscript{25} “The Beginning of Mechanical Engineering at the University of Michigan,” Box 48 Folder – U-M
Mechanical Engineering, Cooley Papers
Michigan graduates, Cooley inquired with the firms’ management to check on their performance.²⁶

The impact Cooley had on his students can be seen in the letters they posted to him. In 1888 one of Cooley’s first students, E.P. Wetmore, took time out from his professional travels to pen a note to the professor. The young engineer was employed by the Sprague Electric Railway Company, and had just completed the installation of several miles of overhead wires for the Harrisburg, Pennsylvania rail system. Wetmore brought to bear all of the training imparted by the Michigan engineering program, detailing to Cooley his time spent drawing plans, working out construction and design details, and estimating costs. Practical shop skills acquired at Ann Arbor were also useful: he performed machine work and electrical work on six rail cars for the Harrisburg system, and superintended the work of other men. Wetmore closed his letter with humble thanks to Cooley: “If I ever make a success in engineering work I shall attribute it to my excellent training I received at the University of Michigan.”²⁷

The education of University of Michigan’s first generation of professional mechanical engineers was based entirely on the Navy style of engineering. Within a few years, universities across the nation followed Michigan’s example. They clamored for Navy engineers to jump-start their mechanical engineering programs, and the engineers responded enthusiastically.

²⁷ Letter, “E.P. Wetmore to Cooley,” (18 June 1888), Box 1 Folder 1888 May-June, Cooley Papers.
The Lure of Academic Life for Navy Engineers

News of Cooley’s quick successes at Ann Arbor circulated among the engineers serving aboard Navy ships, and excited great interest. Some senior engineers took a long view of the possibilities of university assignments. Passed Assistant Engineer David Jones, one of Cooley’s and Spangler’s Academy teachers, frequently wrote encouraging letters to Cooley. From U.S.S. Nipsic in Spain, Jones shared his outlook with Cooley. He thought the program of sending Navy engineers to colleges was “of great advantage to us, by making us known as a body of scientific men.” He continued, “…it is a chance to extend our name and influence through all parts of the country.”

Younger engineering officers also took this view. Walter McFarland wrote to Cooley from Lake Erie in the fall of 1882, expressing his fervent hope to be detached from the old 1842 lake steamer U.S.S. Michigan. “Mac” wanted the Navy to send him to Cornell as an instructor, an opportunity he felt was extremely important: “…if the men in Washington look at it as I do, they would realize that the detailing of officers to colleges in the biggest thing for our corps that has happened in a long time. It will make us known throughout the country and let people see that we are a body of educated gentlemen and not mere engine drivers.”

Like Isherwood in the 1860s, Navy engineers in the 1880s realized that they needed to be respected as professionals if they hoped to win equal footing with line officers in the fleet. Navy engineers consciously moved toward professionalization in their field: the clearest evidence was the creation of the American Society of Mechanical

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Engineers in 1880. ASME elected officers, published a journal of scholarly and technical articles, and limited its membership to a select group of educated, practicing engineers.

Navy engineers were the foundation of ASME and professional mechanical engineering. Former Navy engineer Robert Thurston was elected ASME’s first president in 1880, and served two consecutive terms. The ASME Secretary during Thurston’s second term was Passed Assistant Engineer Thomas Whiteside Rae, a former Annapolis instructor in steam engineering. In that same term, former Navy engineer Charles Copeland served as Treasurer. Thurston’s vice president was also a Navy man: Erasmus Darwin Leavitt; he succeeded Thurston as ASME president in 1882.\(^{30}\)

Active-duty Navy engineers joined the Society as soon as it was formed. Senior Navy engineers encouraged the entire corps to join. For example, ASME member and Passed Assistant Engineer David Jones used his influence with his subordinates to increase ASME membership. Early in 1882, Jones wrote to Cooley in Michigan, “I am inducing as many of our people as I can to join the Am. Soc. Mech. Eng. as I believe it a good organization. Unless you are already provided with proposers, and wish to join, I will be one of your proposers with much pleasure.”\(^{31}\)

Cooley was an early member of the professional society, and other Navy men asked him for nominations so they could join, as well. Walter McFarland asked Cooley to support his membership bid, and to provide any possible assistance to get him an instructor’s position at Cornell. In return, McFarland dedicated time during a brief trip to Washington to arrange for technical models and books to be sent to Ann Arbor.


\(^{31}\) Letter, “Jones to Cooley” (12 March 1882).
McFarland also spread the word among Navy engineers about Cooley’s work in Michigan.\textsuperscript{32}

News and gossip about Cooley’s experiences at University of Michigan spread among Navy officers, and letters began to stream in to Ann Arbor from graduated Cadet Engineers and Assistant Engineers. Some friends just sent congratulatory letters and shared news. However, many more engineers asked Cooley about life on shore and the prospects of more men getting positions like his. Some had selfish reasons for seeking university positions: they wanted to settle down to married life. Others “had quite enough ship” after a few years in the service, and desired escape from the line-staff conflict, incompetent commanding officers, and obsolete, unsafe ships.\textsuperscript{33}

The letters written to Cooley by Frank Bennett are enlightening, and convey the frustrations of Navy engineers at the time. They are also a window on Bennett’s motivation to write his highly political history of Navy engineering.

In the spring of 1883, Bennett described to his friend and former classmate life aboard the old Civil War double-ender, U.S.S. \textit{Ashuelot}. The ship had recently been run onto a rock in the Pacific and lost due to the captain’s negligence. Bennett wrote that the vessel was “about as near an approach to a hell on water as any ship could be” because “her officers were all at swords points with the commander and with each other.” The crew was “a motley gathering of outcasts from all lands but America – undisciplined, dirty, and worthless.” The young engineer told Cooley that his new ship, U.S.S. \textit{Monocacy}, had a splendid set of officers and a decent crew, but problems remained. The

\textsuperscript{32} Letters, “McFarland to Cooley” (7 October 1882) and “McFarland to Cooley,” (21 December 1882).
ship was at the end of its life and was unsafe. “She is so antique in design and so
debilitated by long service,” the engineer moaned, “that it makes us ashamed to go into
port with her.”

Bennett’s discontent did not end at poor equipment; he was dissatisfied with one
of his own corps. The ship’s senior engineer, W.I. Nicoll, was “as near an approach to an
idiot as one can be...; he knows nothing and is continually nagging at some body.” The
ship’s three junior engineering officers were all Annapolis classmates, and believed they
knew much more about engineering than the “ancient officer.” Bennett and the others felt
justified in snubbing him “all the time,” and believed it was payback for sins committed
against them by Nicoll. Part of Bennett’s ire no doubt had its roots at Annapolis: Nicoll
was one of the engineering instructors during Bennett’s education at the Academy in the
1870s, and his eccentricities then infuriated cadet engineers.

Cooley realized his duty at Michigan was far more rewarding that service aboard
ship. He was dismayed when the Navy Department detached him from Michigan in the
summer of 1885 and ordered him to prepare for sea service. This started a string of letters
between Cooley and the Department. He wanted to extend his duty at Michigan another
year, and offered to resign his commission effective June 1886. The Secretary of the
Navy refused to grant his this courtesy, citing “the limited service rendered by you since
leaving the Naval Academy.” Clearly Whitney did not see the value in sending naval
personnel to American universities. In the end Cooley resigned effective January 1886.

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34 Letter, “Frank Bennett to Cooley,” (20 April 1883) Box 1 Folder – 1883, Cooley Papers.
35 Letter, “Bennett to Cooley,” (20 April 1883), Cooley Papers.
36 Letter, “William C. Whitney to Cooley,” (29 June 1885) Box 1 Folder – General, 1885 (April, May,
June); Letters, “Whitney to Cooley,” (7 August 1885); “Cooley to Whitney,” (10 August 1885); “D.M.
Manning to Cooley,” (13 August 1885) Box 1 Folder – General, 1885 (July, Aug., Sept.).
Cooley’s naval service ended, but his connection to active-duty engineers did not. The engineers who maintained the stealiest correspondence with Cooley sought duty as engineering instructors ashore. Bennett was one of these men. From 1884 to 1887, he taught at the Chicago Manual Training School, described by Bennett as “a grade or two above a high school.” This duty was not as prestigious as assignment to a university, but Bennett was happy to relax. He envisioned the duty as “one long picnic.” Though he was supposed to be in charge of machine shop instruction, there were no students advanced enough for that class. Instead, Bennett taught physics, focusing on electricity. He also served as a “sort of adjutant or assistant to the director” of the school. 37

Walter McFarland also frequently wrote to Cooley of his desire to serve at Cornell. In 1883 the Navy granted his wish. In the opinion of another Navy engineer, the college was more a school of mechanic arts than a school of mechanical engineering when McFarland arrived. McFarland’s appointment indicated a change in attitude at the college, a determination to improve engineering education. This resolve was heightened in 1885, when Cornell hired Robert Thurston away from the Stevens Institute of Technology to be the director of the Sibley College of Mechanic Arts. Thurston joined McFarland and a handful of other instructors, and began to build Cornell engineering into a highly regarded program. Cornell mechanical engineering was deep in Navy officers: Passed Assistant Engineers Alfred Canaga (USNA 1874) and Frank Bailey (USNA 1875)

37 Letters, “Bennett to Cooley,” (20 April 1883); “Bennett to Cooley,” (4 March 1884) Box 1 Folder – 1884.
each served tours there in the 1880s. In 1891 Durand (USNA 1880) joined the faculty; he stayed in Ithaca for fourteen years, leaving for a professorship at Stanford in 1905.  

The director of Cornell’s Sibley College, Robert Thurston, understood the value of Navy engineers as instructors, and he worked to hire as many of them as possible. In the fall of 1890 he planned to extend the school’s capabilities by instituting a new program in Maritime Engineering and Naval Construction. He wrote to Cooley, seeking candidate suggestions to chair the new department. Cooley responded that the best men probably would be found in England, but a new tariff law might prevent them from being imported. He put forth the names of three Navy-trained engineers as well. Thurston did not take his advice, for he already had the ideal candidate in mind. Thurston repeatedly sent letters to Cooley, enticing him to leave Ann Arbor for Ithaca in order to chair the department. The Michigan professor politely refused each time. He cited the lucrative consulting business he had built in Michigan, and his belief that his academic duty lay in Ann Arbor.  

The trend evident at Michigan and Cornell of hiring Navy engineers as faculty was a national phenomenon. Navy engineers actively sought billets at universities around the country, and the new land grant universities welcomed them. Schools that would form the Big Ten conference were particularly interested in starting engineering programs with Navy help. Michigan, Purdue, Wisconsin, Illinois, Ohio State, and Penn State all received active duty engineers in the 1880s and 1890s. Officers detailed to those universities wrote

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39 Letter, “Cooley to Robert Thurston,” (26 October 1890) Box 58 – Correspondence January 12, 1889 to December 24, 1890 (Letterpress book), Cooley Papers.

40 Letters, “Cooley to Thurston,” (16 May 1891) and “Cooley to Thurston,” (9 June 1891) Box 58 Correspondence December 26, 1890 to August 5, 1893.
to Cooley for advice and counsel. As his friends in the Bureau of Steam Engineering had
done for him, Cooley shared with new professors his lecture notes, class outlines,
textbook lists, and suggestions for setting up engineering laboratories. Other Navy men
adapted Cooley’s pedagogy at University of South Carolina, Madison University, Union
College, and elsewhere.\textsuperscript{41}

Civilian professors took notice of the new engineering pedagogy Navy men
brought to academia, and mimicked it. From Vanderbilt University in Nashville,
Professor William Magruder requested from Cooley a catalog describing the Michigan
course of study. He was particularly interested in learning about shop practice and
manual technology for engineering students, and asked Cooley to send information about
outfitting a practical laboratory.\textsuperscript{42}

A similar request came from Pennsylvania State College in 1888. Professor Louis
E. Reber asked the Michigan professor for a catalog of courses so he could compare the
two engineering programs. The Penn State Mechanical Engineering department would
graduate its first students the next year, and plans were in the works for a major
expansion of the program. Penn State was about to construct an engineering building with

\textsuperscript{41} Cooley generously shared his experience and knowledge with his fellow officers. See letters in the
Cooley Papers: from University of South Carolina, telegram, “G.W. McElroy to Cooley,” (28 February
1885) Box 1 Folder – General, 1885 (Jan., Feb., Mar.); from Ohio State, letter, “Frank Eldridge to Cooley,”
(24 May 1885) Box 1 Folder – 1885 April-May-June; from Chicago Manual Training School, letter, “Frank
Bennett to Cooley,” (9 December 1885) Box 1 Folder – 1885 October-November-December; from
University of South Carolina, letter, “George McElroy to Cooley,” (3 March 1886) Box 1 Folder – 1886
March-April; from the Michigan Military Academy in Orchard Lake, letter, “Andrew Hunt to Cooley,” (28
February 1886) Box 1 Folder 1886 January-February; from Univ. of Illinois, “A.T. Woods to Cooley,” (16
July 1887) Box 1 Folder – 1887 June and July; from University of South Carolina, letter, “John Edwards to
Cooley: (6 August 1888) Box 1 Folder – 1888 July-August; from University of Wisconsin, letter, “George
B. Ransom to Cooley,” (9 July 1888) Box 1 Folder – 1888 July-August; from Madison University in
\textsuperscript{42} Letter, “William Magruder to Cooley,” (1 November 1887) Box 1 Folder – 1887 November; letter,
“Magruder to Cooley,” (19 December 1887), Box 1 Folder – 1887 December. See also letter “Secretary of
the Technical School of Cincinnati to Cooley,” (2 February 1888), Box 1 Folder 1888 January-February,
Cooley Papers.
laboratories, recitation rooms, drawing rooms, and shops. Reber asked Cooley for floor plans and suggestions for mechanical laboratories. When the new engineering building was ready to open, Penn State invited two Navy engineers to serve as instructors specializing in machine design and mechanical drawing. At Penn State and other universities, Navy engineers provided an intellectual boost to emerging mechanical engineering departments.43

**Navy Engineering Practice as American Engineering Practice**

The emphasis Cooley, Spangler, and their fellow Navy engineer instructors placed on practical experience for their students resulted from their Annapolis education. Annapolis instructors drilled their students in the mathematical and scientific basics, then assigned practical projects to the Cadet Engineers. Practical application of theoretical knowledge has been identified as a defining characteristic of American engineering practice, and it derived from Navy engineering practice.

A comparison of nineteenth century engineering education in France and the United States shows that French technical institutions focused on mathematics and engineering theory, but largely eschewed experimental, industrial research. French theoretical contributions in mechanics, hydrodynamics, thermodynamics, and theory of the strength and elasticity of materials became the foundation for engineering practice.

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throughout the world. American engineers by comparison made few theoretical contributions to their fields.\textsuperscript{44}

However, practical application of theory was a defining feature of American engineering pedagogy in the later part of the nineteenth century. Dozens of US firms and institutions including the Navy consistently carried out industrial research and testing. That research "became the basis for technological innovations of international importance in every imaginable field."\textsuperscript{45}

Sociologist of science Eda Kranakis attributed the differences in the educational systems to social factors, including divergent attitudes toward manual labor between the two nations. She argued that the French disdained workers, while Americans celebrated them. In France this sentiment stemmed from a hierarchical social structure. Places in elite French technical schools were reserved for the upper classes; they deemed intellectual careers proper only for the higher social strata. The French engineers that trained in the best schools worked for the state and formed the apex of their profession. In contrast, engineering was less hierarchical across the Atlantic. Prestigious American technical schools were accessible to a broader segment of the population than corresponding French institutions. American engineers lacked a rigid sense of class. As a result, in the United States there was a high degree of social and occupational mobility. Engineers were able to move freely between government and private-sector occupations, as illustrated by Cooley, Spangler, and their coterie.\textsuperscript{46}

\textsuperscript{45} Kranakis, "Social Determinants," pp. 6-7.
\textsuperscript{46} Kranakis, "Social Determinants," pp. 9, 15, 18, 21.
Conclusion

Naval engineering careers in the late nineteenth century were not attractive for the many of the intelligent, ambitious young men graduating from the Naval Academy. The possessed the best technical education in the nation, but service in the fleet left them frustrated. The ships of the U.S. Navy were obsolete, uncomfortable, even dangerous at sea. Socially, the situation for engineers was equally undesirable. Chances for promotions were few, exacerbating in the 1880s tensions between line and engineer officers. The line-staff conflict escalated to heights paralleling the Porter era. A few highly publicized sinkings due to incompetent commanding officers cast line officers in a negative light, but those officers were the exceptions in an otherwise professional corps. All of these factors contributed to engineers’ move toward professionalization.

If the engineers were seen as a scientific, professional body of experts, they would gain national political influence. That could be translated into authority within the Navy, which could improve the situation of active-duty engineers. The formation of the American Society of Mechanical Engineers was one certain path to professionalization. ASME was largely a Navy clubhouse in its first years, with Navy engineering officers filling the key leadership positions.

Another avenue toward professional status for engineers was increasing the barriers to entry. This was accomplished through academic training at universities. Again, Navy engineers guided their field. The legislative efforts of Navy engineers in 1879 allowed Mortimer Cooley, Robert Thurston, Henry Spangler, William Durand, and dozens of other Navy engineers to establish themselves as eminent professors across the nation in ensuing decades. Those men took with them the Annapolis style of engineering
instruction. It was built upon foundations of advanced mathematics, basic science, and theoretical knowledge; these underlay experimental laboratory investigations and practical shop experience. Navy engineering practice became American engineering practice, and it was distinct from European styles. By the 1890s, American universities turned out thousands of professional mechanical engineers trained in the Navy style. This group of technically competent men was one reason for American industrial dominance at the turn of the century.
Chapter Ten – Navy Engineers in Industry

Introduction

Not all Annapolis-trained engineers dissatisfied with the service found careers in academia. Some applied their engineering education to industrial or business careers. Details of Navy veteran engineers’ industrial careers are scant, but the professional and social networks they established during years in the Navy are visible. The following case studies begin to illustrate the contribution Navy engineers made to American business around the turn of the century.

Frank Jameson Symmes

One of the original 1866-68 Annapolis engineers was Frank Jameson Symmes, born July 7, 1847 in Kingston, Massachusetts. In his teens he attended the Lawrence Scientific School at Harvard University, studying engineering amongst a class of thirty-eight students. He graduated from Harvard in 1866 and entered the graduate program in steam and mechanical engineering at the Naval Academy in 1867.¹

Symmes excelled in practical engineering at the academy. He ranked second only to valedictorian Bray in studies of applied mechanics and iron ship construction. He had some difficulty with chemistry and metallurgy, placing tenth in the class of sixteen. In steam studies he fared worse, filling the twelfth rank. He graduated in the middle of his class in 1868, received his warrant as Third Assistant Engineer, and shipped out for duty with the Pacific Squadron.²

² Annual Register of the USNA, 1868-69, p. 39.
During his Navy tenure he lived in the Pacific Squadron’s laboratory of American marine steam engines, a remarkably eclectic mix of old and new steam technology. The Navy transferred him among various billets for three years in the Pacific, and for at least one extended cruise he tended the engines of the squadron’s flagship. The young engineer also spent considerable time at the Mare Island Navy Yard near San Francisco. Mare Island was a vital base, the nation’s only repair and refit facility in the Pacific.³

In 1869 the Navy promoted Symmes and transferred him to U.S.S. Pensacola. Thermodynamic debate over the original engines of Pensacola between Isherwood and Dickerson was the major contributing factor in the formation of the 1866 Annapolis engineering program. Pensacola had been repowered with Isherwood’s engines long before Symmes joined her, so the engineer was not saddled with the care of Dickerson’s monstrosities. Symmes might have had an opportunity to hear Isherwood’s views on the subject of the long versus short cutoffs in marine steam engines. Soon after Symmes joined the ship, Isherwood arrived in San Francisco after his demotion at the hands of Admiral Porter. The former Bureau Chief remained in San Francisco from September, 1869 to the autumn of 1871. Symmes was based in Mare Island for that entire period.⁴

Early in 1870, Second Assistant Engineer Symmes sailed from San Francisco on Saranac. This billet was important to Symmes for social reasons. The ship carried Admiral Turner, commander of the Pacific Squadron; his Chief of Staff, Commander P.C. Johnson; and Fleet Engineer W.S. Stamm. The cruise brought Symmes along the coast of Lower California, Mexico, Panama, Peru, and Chile before returning to San

³ *Army and Navy Journal* v. 6 (January 2, 1869): 308; Hamersly, *Records of Living Officers*, pp. 313-366; Bennett, Appendix A.

⁴ The Fleet Engineer for the North Pacific at the time was Edward Dunham Robie. Hamersly, *Records of Living Officers*, pp. 313, 336.
Francisco and provided the freshly commissioned engineer with months of exposure to influential flag officers.\textsuperscript{5}

Symmes returned to Mare Island at the end of the cruise, and realized that his career prospects were not bright in the shrinking peacetime Navy. The twenty-four year old chose to leave behind his naval engineering aspirations. Symmes married San Francisco native Anna A. Day on March 30, 1871, and resigned from the Navy three months later. He became a salesman with the Thomas Day Company in San Francisco, owned by and named after his father-in-law. The young engineer's education with various steam engines and their fittings overqualified him for his new job; the Day Company was a gas, plumbing, and electrical fixtures dealer.\textsuperscript{6}

\textit{Figure 27 – Frank Symmes in the late 1860s. Image: USNA Archives.}

Symmes married into a wealthy family at a providential juncture. Thomas Day senior was a cautious elderly gentleman who established his business in the early 1850s.

\textsuperscript{5} Army and Navy Journal v. 7 (Feb 12, 1870): 402; Army and Navy Journal v. 7 (April 30, 1870): 577; Hamersly, Records of Living Officers, pp. 313-366; Bennett, Appendix A.

\textsuperscript{6} National Cyclopedia v. XVII, p. 169; Army and Navy Journal v. 8 (July 22, 1871): 783.
Through careful, steady attention to his affairs he amassed by 1870 a fortune in real estate and business worth an estimated $200,000. In testimony to Day's character, an agent for R.G. Dun reported "His word is as good as his bond." The same could not be said for the businessman's son. Day opened a second store in San Francisco and put his son Thomas in charge with a stake of $8,000. The younger Day drank, gambled, and squandered the capital for half a year until his father relieved him of managerial responsibilities and demoted him to store clerk. The same Dun agent who effusively praised the elder Day described the son in colder terms: "...a wild, giddy young man. Thomas has no responsibility of himself. His wild oats not yet sown." The wedding of Frank Symmes and Anna Day followed young Thomas Day's business debacle by less than a year.

The aging Thomas Day Senior must have been heartened with his daughter's match. Living among the Pacific Squadron's flag officers conditioned Symmes to wealth and prestige, and the former engineer moved swiftly through the ranks of the family business. Within a decade the Navy veteran was a vice president of the firm, and from 1886 to 1903 he was president of Thomas Day and Co. Like his father-in-law, Symmes was noted for his business ability and honesty. In 1903 he became president of the Central Trust Company of California, a position he held until 1907. A trusted, honorable man, Symmes was appointed receiver for the insolvent Citizens' State Bank of San Francisco in 1908. His business career was a string of successes, complemented by an equally satisfactory family life.

Symmes and his wife were the parents of two sons and two daughters. The engineer-turned-banker passed his proclivity for things technical to his progeny. His son

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7 R.G. Dun Report, California Volume 13, p. 137.
8 R.G. Dun Report, California Volume 13, p. 176.
Leslie was a consulting engineer in San Francisco. Leslie’s brother, Whitman, was mining engineer and manager of the Mexican Ophir group of Comstock Mines at Virginia City. Engineering had attracted sons of well-to-do families since the antebellum period. The Symmes family was wealthy and well respected in California society; that the sons chose those technical professions demonstrates that engineering was a suitable career for upwardly mobile American gentlemen at the end of the century.\textsuperscript{10}

Symmes encouraged technical education both for his sons and for the community, and he was an active participant in refining technical pedagogy. He was a member of the San Francisco Board of Education 1894-1895 and served as vice president of the California School of Mechanical Arts. Symmes also retained his interest in the navy. He was director of the Navy League of the United States and a member of the United States Naval Institute. In 1899 his concern for engineering education and his continuing connection with the Navy merged. He served as Vice President of the Board of Visitors for the U.S. Naval Academy in that year.\textsuperscript{11}

The Board consisted of ten men, headed by U.S. Representative John Dalzell. Symmes served on two subcommittees: Projected Improvements and Improvements in General, and State of Discipline. The Improvements subcommittee recommended extending the limits of the Academy, increasing the dormitory and academic spaces on campus, and constructing a hospital. The Discipline subcommittee reported that the cadets seemed highly disciplined and thoroughly instructed in practical exercises: artillery and infantry drills, and evening dress parades. The general recommendations of


the Board of Visitors showed the influence of the former engineer. The Board urged a supplement of $5000 for the purchase of additional apparatus and machinery for the engineering department, along with an increase in funds for suitable books for the library.\textsuperscript{12}

Symmes maintained his relationship with the Navy into the final years of his life. In a letter typed to a Naval Academy professor in November 1914, Symmes explained that he had attempted to establish an organization of US Naval Academy graduates living on the West Coast. He noted, "The principal interest of such an occasion comes from the intermingling of those who have left the service and those who still remain there...."

Symmes cared enough about his former life in the Navy that he was willing to pay for the memories. The handwritten post script to his letter stated, "We used the senior graduate present as the presiding officer and I usually did the rest – and usually to the extent of correcting a deficit!"\textsuperscript{13} He enjoyed socializing with Navy officers, whether line or staff, and up to his death in 1916 he exhibited no trace of bitterness toward the line. Other Navy engineers left the service for industry because of intraservice conflict; for them, reconciliation with the line came less easily.

\textbf{Asa Martines Mattice: Commercial Engineer and Activist}

For more than a decade Asa Martines Mattice was a central figure in the line-staff dispute. He came to the fore in the late 1880s, and he continued his fight in the 1890s after resigning from the service. His career as an activist was unique among his Navy

peers, yet he started much like any other post-war engineer in the fleet. Mattice was born in Buffalo, New York in 1853. He left his hometown when he was seventeen years old to study engineering at Harvard's Lawrence Scientific School. He graduated two years later, and won an appointment to the Annapolis graduate engineering program. He entered the Naval Academy in 1872, a member of the two-year engineering course re-established under Superintendent John Worden.\textsuperscript{14}

Mattice served in the Navy afloat and ashore for the next eighteen years. His duties included tours as an instructor at the Naval Academy, and several years as a designer in the Bureau of Steam Engineering. In 1888 he was a founding member of the Society of Naval Architects and Marine Engineers, SNAME. Helping to establish the Society was the swan song of Asa Mattice's active Navy career. He took a leave of absence in January 1889, expressing his plan to become a consulting engineer in Boston. He resigned from the Navy after his year's leave, citing "the thousand and one incidents which combine to make the life of an officer in the staff corps exceedingly unpleasant."\textsuperscript{15}

Mattice took a job as assistant to consulting engineer Erasmus Darwin Leavitt, a well-known and respected professional. Leavitt was a founding member and second president of the American Society of Mechanical Engineers. Born in 1836 and raised in Lowell, Massachusetts, he had been reared in the shop culture of pre-war engineering. When he was sixteen years old he began a three-year apprenticeship in the Lowell Machine Shop, and afterward worked for a number of engine-building firms. During the war he joined the Navy as an engineer, and then spent two years as an instructor at the

\textsuperscript{13} Frank Symmes, Letter to Prof. D.M. Garrison, U.S. Naval Academy, November 5, 1914. Original document held in Alumni File “Frank Symmes”, United States Naval Academy Archives/Special Collections.
Naval Academy. When Porter launched his anti-engineer campaign in 1867, Leavitt left Annapolis to start a consulting firm in his home state.

Leavitt’s earliest contracts were designs for water pumping engines for two Merrimack River textile centers, Lawrence and his native Lowell, Massachusetts. This work brought him to the attention of the directors of the Calumet and Hecla Company in 1874. Calumet and Hecla operated copper mines and railroads in Michigan, and the company was worth millions of dollars by 1884. Leavitt designed the mining company's massive pumping and hoist engines, a lucrative and publicity-generating contract. Significantly, Calumet and Hecla's superintendent and part owner, Hillary Missimer, was a former Navy engineer. Social and professional links forged in the fleet remained strong when engineers joined civilian life. Asa Mattice became a part of this post-service network when he took charge of Leavitt's design room in 1890. He was able to strengthen his connections to other Navy veterans in industry by field sojourns to inspect engines already in place, including the enormous Leavitt machinery in Michigan.16

Working for Leavitt provided Mattice with exposure to important American industries. In addition to several engines for Calumet and Hecla, Mattice's draughting pen provided designs for furnace pumps at Bethlehem Steel Company's gun and armor forging plant. Bethlehem had links to Navy engineering. Former Navy engineer Edward

15 Army and Navy Register v. 9 no. 51 (December 22, 1888): 803; Mattice, “Queer Doings,” p. 1
O'Connor Acker was superintendent of the steel tempering plant in 1893. These mammoth companies found E.D. Leavitt Company's design work quite valuable, and other industries contacted the firm for engineering help.

In 1893 the Pope Manufacturing Company of Hartford, Connecticut, offered to hire Mattice as a consultant. Pope was an industry leader in innovation and practitioner of the armory system of manufacture. Its owner, Albert Pope, had learned from other manufacturers with longer traditions of innovation. In 1890, Pope gained control of the Weed Sewing Machine company, a firm that since the 1860s had produced in succession firearms, sewing machines, and finally bicycles. When Pope approached Mattice, the company was gearing up for a production boom in Columbia safety bicycles. Harold Hayden Eams, Pope's Trade Manager and a class of 1882 Annapolis graduate, sought Mattice's design expertise in pumping engines and hydraulic work in general. Mattice declined to consult independently, and referred Eams to his employer. He noted, however, that Leavitt's draughting room was overcrowded with work, and that it would be a month before even general advice could be rendered. Eams decided it was worth the wait, and later purchased machinery designed by Mattice.¹⁸

The engineer had several other projects underway at the time. E.D. Leavitt Co. held the design contract for three immense sewage pumping engines for the city of Boston, and the main sewer lines that would feed them were nearing completion. Cambridge's City Water Works retained the company to provide plans for another

¹⁸ David Hounshell, From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States (Baltimore: Johns Hopkins University Press, 1984), pp. 200-203; Bruce Epperson, "Failed Colossus: Strategic Error at the Pope Manufacturing Company, 1878-
massive pumping engine. Mattice collected rainfall data for the area in order to calculate the necessary flow for these pumps, and compared that data to information from other cities. He then designed the Boston and Cambridge engines, and later followed up with reports on their functions.\(^{19}\)

After a decade with E.D. Leavitt, Mattice accepted the position of Chief Engineer with Westinghouse Electric and Manufacturing Company in 1900. Again, connections between industry and the Navy played a role in securing employment. Westinghouse Vice President Benjamin Warren graduated from Annapolis with Mattice in 1875, and the company's Chief Electrician, Oliver B. Shallenberger, graduated from the Academy in 1882. In his new job, Mattice oversaw the development of several products, including generators for New York City's subway and elevated trains, very large turbo-driven generators, and new lines of standard D.C. and A.C. motors. Mattice spent three years with the Electric and Manufacturing Company, and then moved to the Westinghouse Machine Company. Another Navy connection existed there. Acting Vice-President Walter McFarland graduated Annapolis in 1879, taught at Cornell in the middle of the 1880s, then returned to the fleet and served into the 1890s.\(^{20}\)

At Westinghouse Machine, Mattice showed his technical and political skills. Following a procedure that presaged some aspects of Taylorism, Mattice arranged the shop apparatus so as to avoid difficulties in its use and "consequent expense." McFarland

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19 Mattice, "Table of Rainfall at Chestnut Hill Reservoir for Year Ending December 31, 1893," Mattice Papers; Letter, “Mattice to George Cox” [Regarding Flow of Sewage into Schuylkill River, Philadelphia], (5 November 1894) Mattice Papers; McFarland, "Obituary," p. 655

20 Mattice, “Queer Doings,” p. 1; *New York Times* (April 21, 1925): 21; Cathcart, "John Christian Kafer," p. 94; McFarland, "Obituary," p. 657. George Westinghouse also had some Navy background: he volunteered for duty during the Civil War. He was an Acting Third Assistant Engineer from December 1, 1864 until the end of the war, serving aboard the third-rate double-ender *Muscoota*. 

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noted that when Mattice designed a line of apparatus, the engineer always solicited the criticism of the shop foremen who would handle it. McFarland stated that the foremen greatly appreciated the compliment Mattice paid to their judgment, and the practice kept labor relations harmonious on the shop floor.  

In 1904 Benjamin Warren left Westinghouse to become president of Allis-Chalmers Company, and he hired Mattice as Chief Engineer in charge of manufacturing. The company planned to extend its product line to include the Fullager-Parsons steam turbine, turbo-generators, and hydraulic pumps. Mattice was responsible for these projects, as well as the construction plans for the Allis-Chalmers works at Milwaukee. After two years of intense work, Mattice and Warren left Allis-Chalmers. With former Navy engineer Christian Kafer, they started their own firm of consulting engineers. When his two partners died in 1906, Mattice abandoned the business and became Works Manager at Walworth Manufacturing Company in Boston. Another Navy connection led him to Walworth: former Navy engineer Levi Greene was the company's longtime managing engineer. Mattice retired from business in 1911. He was enticed back into engineering during World War I, when he consulted for the Remington Arms Company. He remained an Advisory Engineer for Remington until his death in 1925.  

Conclusion

The post-service career of Frank Symmes reflects the adaptability of Annapolis graduates. Symmes was an intelligent, politically skilled professional. San Francisco was ripe with opportunities for a man of Symmes' abilities, and his partnerships with the Day

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22 Ibid., p. 658-660.
family provided him with a vehicle to wealth and prominence. It is likely that the line-staff conflict only peripherally affected his decision to leave the Navy, though he may have been prejudiced against a naval engineering career after meeting Benjamin Isherwood during that officer’s exile to Mare Island. Instead, the reduction of the steam fleet during Symmes’ short Navy career probably contributed to his decision to abandon government service for a career in the private sector.

Asa Mattice is another story. He quite explicitly resigned from the Navy as a result of the rekindled line-staff conflict near the end of the century.

Mattice’s remarkable career reflected the trends in late nineteenth century engineering. He was a product of school culture engineering, and colleagues stated that his knowledge was encyclopedic and his classroom intellect sharp. But, like most American engineers, he employed theory as a means toward practical ends. Mattice conveyed the Navy philosophy of practical application of theory when he was an instructor at the Naval Academy. Some of his fellow officers transferred those Navy teaching methods to other institutions when they were detailed to college engineering programs.

Mattice and his colleagues self-consciously built engineering into a respected profession. They did this by organizing professional societies, complete with specialized publications. The fight for recognition within the Navy was another component of this process of professionalization. During the contentious years of the controversy, Mattice’s writings crossed the desks of engineers, Congressmen and naval policy makers, including Mahan. Upon leaving the Navy, the engineer worked for companies on the cutting edge of industrial technology: Pope Manufacturing, Bethlehem Steel, Westinghouse, and Allis-
Chalmers. Mattice also contributed to the social improvement programs of the
Progressive Era; he consulted on sanitation projects in Boston and Cambridge. Asa
Mattice's career above all showed the impact the United States Navy had on the growth
of engineering and the American economy in the late nineteenth century.
Chapter Eleven – Conclusion

Anxious European witnesses watched an American phoenix hatch from the ashes of the Civil War and begin a climb to industrial domination. Manufactured goods poured from the nation’s factories in the late nineteenth century. These were hallmarks of American culture, spread globally through trade and imperialism as the reborn United States edged out older nations in world markets. Europe had reason to feel unsettled with this emergence. To Victorian eyes, industrial prowess signified unmistakably a nation’s progress.

Histories seeking the reasons for America’s ascendancy abound. American exceptionalism is a phenomenon with many fathers: various historians have paid homage to the frontier, liberal political and economic institutions, and the continent’s rich natural resources. Along with these factors, federal sponsorship of technology must be added as a contributor to the creation of American hegemony.¹

Federal technology sponsorship before the Civil War most obviously stemmed from Army roots. It took a variety of forms. Army engineers oversaw construction of railroads and canals; these transportation technologies eased movement of goods and people and spurred the antebellum economy. Once that physical infrastructure was in place, Army management and accounting techniques helped railroads mature into industrial giants. Perhaps as significant for the development of a uniquely American style of industrial production, the Army long supported uniform parts manufacturing techniques. All of these Army-sponsored projects predate the war. The Army helped

build the foundation of American industry in the early period, but Army technology contributions in the last half of the century were meager. Where did federal technology sponsorship go in the late nineteenth century?

The Navy is one answer. After 1865 the Navy continued the practice of technology sponsorship by establishing a fundamental industrial building block: professional mechanical engineering knowledge. The mechanical engineering curriculum developed at Annapolis was flexible. It combined theoretical instruction with practical applications. Engineers graduated from the Naval Academy in the 1870s possessed the best technical education available worldwide, and were competent academic and industrial leaders.

The post-service records of several Navy engineers prove this. In academia, American universities recruited Annapolis-trained engineers as professors beginning, with the men of the 1866 pilot program. This trend quickened after 1879, and by 1890 emerging elite institutions such as University of Michigan, Cornell, and University of Pennsylvania featured Navy men in their engineering departments. Other established schools including Harvard already counted Navy engineers among their faculty. Later, in the twentieth century, Navy engineers served at still more top institutions as professors of electrical engineering and aeronautical engineering. For instance, William Durand left Cornell for Stanford in 1904. The multiplier effect of professional training for engineering students at these and other schools contributed to the explosive growth American industry in this period.

In industry of the late 1800s, Navy engineers were as prominent as Army engineers had been earlier in the century. Navy staff officers served as vice presidents for
some of the mammoth new companies: a few examples illustrate their significance. From
the early 1880s, Navy engineers formed the top management and technical echelons of
Westinghouse Machine and Westinghouse Electric. Later, that clutch migrated en masse
to Allis-Chalmers Corporation. Naval Academy engineering veteran Edward O'Connor
Acker (USNA 1879) headed Bethlehem Steel's armor production plant. Another former
naval officer, Henry Missimer, served as vice president for the country's largest mining
concern, Calumet and Hecla.

Companies clamored for Navy engineers for reasons beyond their education and
technical skills. Their political connections aided employers in obtaining government
contracts. They were accustomed to managing workforces. They also maintained strong
personal and professional networks, allowing companies to recruit additional engineering
talent easily. By hiring a Navy veteran, a company or university was able to tap all of
these resources.

Some similarities exist between the century's bookend experiences of Army and
Navy engineers, but in one striking way the Navy trajectory diverged. The Army's
sponsorship of technology was always goal oriented, though those goals evolved through
the years. The classic example remains the pursuit of uniform parts manufacturing,
superseded later by the interchangeable parts manufacturing of the American System. A
series of patrons and administrators directed that program toward a clearly defined end.
In contrast, every critical juncture in the Navy engineering path developed as a reaction
to other events. For instance, the Navy introduced steamers into the fleet in the 1840s as a
reaction to the repeated war scares with Great Britain. George Bancroft founded the
Naval School in 1845 in reaction to Navy officers' ignorance of steamships; part of the
education at Annapolis therefore was geared toward engineering. Again in 1866 the Navy reacted to obvious shortcomings in its officers’ corps; the light draft debacle and the Isherwood-Dickerson battles forced the Navy to institute components of iron ship construction and thermodynamics in the engineering program. In the resolve to remedy the engineering problems apparent during the Civil War lay the genesis of the Navy’s unique curricular combination of practical and theoretical training.

Another reactive program was the legislative campaign that allowed Navy engineers to become professors. The line-staff conflict closed engineers’ avenues to professional advancement in the Navy. The engineers turned to careers in civilian institutions as a way to measure their self-worth. They carried with them to American universities the Navy engineering pedagogy of practice and theory. At no point did anyone in the Navy foresee the effects of the engineering program at Annapolis.

Despite this reactive nature, the nation derived significant benefits from Navy engineering programs. By the turn of the twentieth century, Navy engineers directed engineering education, industrial endeavors, and development of new warship designs. They also served as political and technical advisors to Washington. What conclusions are we to draw, then?

First, government sponsorship of military technology is a double-edged sword. The threat of a society dominated by the military always lurks behind enormous defense budgets. However, the technologies and knowledge developed under those defense programs are not inherently negative. This is particularly true when defense dollars fund basic research or enhance education. The long term effects and impacts of military technology development programs are not self-evident. Spin-offs cannot always be
predicted. Critics of defense spending must take into account the benefits that have been derived from government programs, as well as the reprehensible outcomes.

Second, the American method of government technology funding may be a defining element of this nation's economic power. Federal money supports nascent technologies, but at their maturation the government allows the private sector to assume control over them. The list of historical examples continues to grow as social scientists focus their gaze on the subject. Navy-derived mechanical engineering joins studies of railroads, interchangeable parts manufacturing, and digital computing. It is not difficult to think of other examples of twentieth century technologies originally funded by the military with subsequent civilian applications: radar, sonar, microwave communication, digital signal processing, the Global Positioning System. Around each of these technologies, new industries coalesce.

All of these twentieth century cases share a key component. Academically trained engineers conducted the research that made them possible. The crucible of that professional engineering skill was the United States Navy.
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