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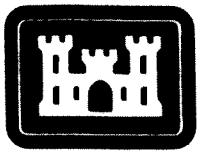

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NATIONAL HISTORIC CONTEXT FOR DEPARTMENT OF DEFENSE INSTALLATIONS, 1790 - 1940

Volume I of IV

August 1995

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Prepared for

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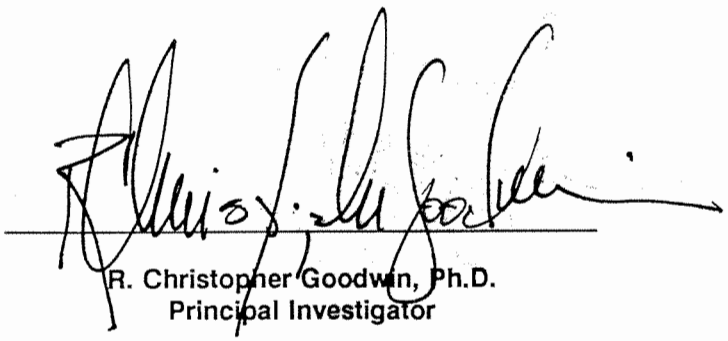
NATIONAL HISTORIC CONTEXT FOR DEPARTMENT OF DEFENSE INSTALLATIONS, 1790 - 1940

FINAL REPORT



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EXECUTIVE SUMMARY

The *National Historic Context for Department of Defense Installations, 1790 - 1940* is a Legacy Resource Management Program demonstration project that provides a methodological and historical framework for the assessment of the relative significance of Department of Defense (DoD) historic properties within the context of nationwide military construction. The project examines the historical and architectural evolution of construction on military installations located in the contiguous United States from 1790 to 1940. The purpose of the project is to assist DoD in the execution of its responsibilities for cultural resources under the National Historic Preservation Act of 1966, as amended, applying the Secretary of the Interior's Standards for Preservation Planning and the guidelines of the National Register Program. R. Christopher Goodwin & Associates, Inc., undertook this project on behalf of the Legacy Program, through the Baltimore District, U.S. Army Corps of Engineers.

The Department of Defense (DoD) manages a range of unique cultural resources associated with the historical development of the U.S. military, as well as many other aspects of North American history and prehistory. Cultural resources are tangible reminders and symbols of our national heritage. Federal legislation requires federal agencies to establish cultural resource management programs. DoD regulations implement cultural resource management programs, which are on-going functions within the military services. Installation and activity commanders are responsible for compliance with the National Historic Preservation Act (NHPA). This project will assist DoD cultural resource program personnel with the identification, evaluation, and management of cultural resources required under NHPA.

As installation-based cultural resource programs evolved, DoD recognized the complex historical inter-relationship of properties associated with the military services. Assessment of the relative historical significance of DoD properties required comprehensive comparative data on the historical development of DoD construction. The Legacy Program offered DoD the opportunity to compile and synthesize comparative information on DoD historic properties.

The results of this project are designed for use by anyone concerned with the management of DoD historic properties built between 1790 and 1940 in the United States (excluding Alaska and Hawaii). DoD cultural resource managers, contractors, and State Historic Preservation Officers will find relevant historical data organized in a manner consistent with federal historic preservation planning standards. Through this project, the Legacy Program sought to provide basic background and comparative information in a cost-effective manner. DoD personnel and contractors undertaking the identification and evaluation of historic buildings on DoD installations can assess the relative significance of pre-1940 military construction without conducting extensive background research to develop the appropriate national historic contexts. The National Military Context provides comparative data that enables the analysis of site-specific information within the broad pattern of nationwide military construction activities. Understanding these broad patterns of history is crucial to the identification and evaluation of historic properties. Historic contexts provide an organizing framework for understanding history. This framework forms the basis for cultural resource identification, evaluation, and management activities under NHPA. Without an appropriate context, an historic property is identified and evaluated in a vacuum that does not allow adequate assessments of relative significance. A single source for comparative data on DoD historic properties will eliminate redundant effort.

The National Military Context is a planning document that integrates the three components of an historic context -- time period, geographic area, and theme -- with associated property types. This approach establishes the connections between real property and major historical themes in

military history. The report presents a system for categorizing historical data related to military construction so that the relative importance of DoD real property can be assessed within broad nationwide patterns of military development from 1790 to 1940.

The National Military Context is organized into five major parts, contained in four volumes: Chronological Overview; Theme Studies; Property Types; Installation Site Reports; and, National Register Nomination Case Studies. Each part of the National Military Context is suitable for use as a free-standing document or in combination with other sections of the report. Introductions preceding each part of the report provide a summary of the data presented in the section, guidance for its application, and direction on the integration of the section with other parts of the report. An introduction to the project and a discussion of the application of the project is contained in Volume 1.

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Cultural Resources in the Department of Defense

The Department of Defense (DoD) manages 25 million acres within the United States. These lands contain a range of properties associated with the historical development of the military, as well as with many other facets of North American history and prehistory. Cultural resources are non-renewable resources that document the historical development of the nation; they include real property, personal property, records, and community resources.

Military cultural resource programs, including the identification, evaluation, and management of historic properties, are on-going functions within the respective services. Although Federal Preservation Officers for each service provide guidance in cultural resource management, responsibility for the majority of DoD cultural resource management duties falls upon individual installations, activities, and commands.

As installation-based cultural resource programs evolved, DoD recognized the complex historical inter-relationship of properties associated with the military services. Military construction typically was planned and executed as part of a national defense program. As a result, assessment of the historical significance of properties on DoD installations requires comprehensive comparative data on the historical development of DoD construction. Such comparative data provides a basis for developing consistent management strategies for historic properties. Through the development of comprehensive historic context studies, DoD seeks to provide background and comparative information in a practical and cost-effective manner that is in the public interest.

Legislative Background

The National Historic Preservation Act (NHPA) of 1966, as amended, established the legislative basis for federal historic preservation programs. The act established the National Register of Historic Places, the national inventory of properties significant in American history, architecture, engineering, archeology, and culture. The National Register is continually updated to include significant properties that represent many facets of American history. Section 110 of NHPA requires federal agencies to identify, evaluate, and nominate to the National Register historic properties under their control or jurisdiction. Section 110 also requires federal agencies to consider the preservation of the cultural and historical values of historic properties under their control or jurisdiction (16 U.S.C. 470h-2).

The Section 110 Guidelines, developed by the Advisory Council on Historic Preservation, direct federal agencies to establish historic contexts to identify and evaluate historic properties (53FR 4727-46). The *Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation* provide technical guidance about historic preservation activities and methods, including identifying and evaluating historic properties.[1] These guidelines also recommend developing historic contexts to assist with preservation planning.

National Historic Context for DoD Installations

The *National Historic Context for Department of Defense Installations, 1790 - 1940* (National Military Context) examines the historical and architectural evolution of construction on

military installations from 1790 to 1940 in the contiguous United States. Military construction during the 150 years prior to World War II reflects many of the events and trends that shaped the nation and constitutes a major portion of the military's real property inventory. An historic context provides an organizational framework to assist with interpreting and assessing the broad patterns of history. The importance of a property can be understood only within its historic context.

The purpose of this project is to assist the Department of Defense with meeting its responsibilities under Section 110 of the National Historic Preservation Act of 1966, as amended. The results of this study provide a methodology and an historical framework that will assist DoD in assessing the relative historic significance of military construction completed prior to World War II. The National Military Context will assist DoD cultural resource managers with fulfilling their Section 110 responsibilities through:

- the synthesis and analysis existing survey data;
- the development of a consistent historic context that encompasses a large segment of DoD properties; and,
- the establishment of a standard methodology for the identification and evaluation of historic properties.

The *National Historic Context for Department of Defense Installations, 1790 - 1940* is a planning document designed to provide cultural resource managers with the framework necessary to fulfill their Section 110 responsibilities for pre-1940 military properties. The report provides an analysis and synthesis of military history and themes directly related to pre-1940 real property under the current stewardship of the Department of Defense. The report is designed for easy reference and selective use. It is not intended to present a comprehensive military history or catalog of DoD real property, nor is it intended to replace installation-specific identification and evaluation efforts. Instead, the National Military Context provides the basis upon which installation-specific information can be identified, evaluated, and managed in compliance with federal and DoD regulations in a consistent and cost-effective manner. DoD personnel, State Historic Preservation Offices, and others seeking to identify and evaluate historic buildings on DoD installations can consult nationwide context studies to obtain comparative data on similar properties without conducting extensive, repetitive research.

Research Design

A primary objective for the research design for the National Military Context project was the development of a practical historic context for use in and by installation cultural resource programs. This study can be used by cultural resource program managers from all four services who manage varying numbers and types of historic properties, from small naval stations to large infantry posts. The research design for this study:

(1) complies fully with established standards and guidelines for preservation planning (Secretary of the Interior's Standards for Preservation Planning and the guidelines of the National Register of Historic Places);
(2) allows for the integration of data from previous and future cultural resource investigations;
(3) establishes clear and logical links between historical patterns and events and real property;
(4) assists with all stages of historic property identification, evaluation, and management activities;

(5) utilizes a case study approach to illustrate its application; and,

(6) presents the results in a manageable and accessible format for selective reference.

The National Military Context relies on two central concepts used in evaluating National Register eligibility. These are **historic context** and **historic integrity**. An historic context is an approach to organizing data according to geographic location, time period, and theme. The local, state, or national significance of a property is assessed within its appropriate historic context. Historic integrity is the ability of a property to convey its significance through its physical characteristics.

The National Military Context integrates the three conceptual components of an historic context - **time period**, **geographic area**, and **theme** - with associated **property types**. This integration is designed to establish clearly the connections between major historical themes in military history and real property.

The project scope-of-work provided the **time period** -- 1790 to 1940. This period covers the development of the military from the early national period to World War II mobilization. The cut-off date of 1940 was selected because building types and construction techniques applied during the World War II mobilization effort differed substantially from those preceding it. Separate research projects focus on the World War II period.

The scope-of-work also defined the **geographic area** for the investigation -- the contiguous United States. Thus, military construction in Hawaii, Alaska, and the U.S. territories was not included in the project. Although the initial research design called for the subdivision of the United States into regional units to facilitate the collection and analysis of information, this approach was abandoned after several unsuccessful attempts to establish meaningful regional divisions. The failure of a regional framework to provide a meaningful categories for military construction reinforced the need for an overall national context for military construction.

The scope-of-work also defined the **theme or subject matter** -- military construction. Therefore, properties on military installations that pre-date military acquisition of the land are not included in the historic context. The military owns many properties, such as farmhouses, churches, and lighthouses, that were standing when the federal government acquired land for military installations. Properties not built by the military are not related to the property types discussed in this report. The historic significance and integrity of those properties are best understood within local or regional historic contexts, though subsequent military uses of those properties may be related to the chronological periods and themes identified in this project. The project scope-of-work also specified examination of military construction at active-duty installations. Therefore, the study emphasizes the historical developments and property types related to the types of installations that remain under DoD control. The military no longer maintains large numbers of some types of installations, such as early nineteenth-century posts east of the Mississippi River, or late nineteenth-century coastal defenses, that once constituted a major part of the military inventory.

Methodology

Five primary tasks were completed in the implementation of the research design. These were archival research, field investigation, data synthesis, context application, and report preparation. Data were collected and analyzed to identify the broad patterns of military history

and trends over time; to develop specific historic themes; and, to identify property types related to military construction.

Archival Research

The broad trends and patterns of the U.S. military from 1790 to 1940 were analyzed in order to understand how individual installations fit into the larger pattern. This analysis included a chronological narrative that described the evolving roles and missions of the military services, and that linked these missions to the physical development of military installations. The chronological narrative divided the military history into four periods, in order to provide a conceptual framework for the development of the armed forces. The context also included analyses of specific themes that were identified as especially relevant to military installations.

While recognizing the differences between the services, this analysis emphasized the common trends that reflected the role of the armed forces in the rising international power of the United States. Because this study concerned the evolution of the military services as institutions, it emphasized peacetime developments, rather than combat operations.

The research process began with review of the standard histories of the military services. These works included the synthetic histories of each service, such as Alan Millet's *Semper Fidelis: The History of the United States Marine Corps*, and more narrowly focused research, such as Francis Prucha's *Sword of the Republic: The United States Army on the Frontier, 1783-1846*. These studies helped establish the conceptual framework for analysis, and identified a number of important issues subsequently included in the context analysis. The research subsequently focused on specific analyses of roles and missions, and on the growing sophistication of the military services.

The next step in the research process was to link the evolution of the armed forces to individual military installations. This step necessitated review of a variety of primary and secondary sources. Some of the most fruitful secondary sources included published monographs and dissertations on specific installations, as well as works about military life in general. Primary sources included contemporary histories of installations and events, plus relevant government documents. These materials were identified using standard library research methodology, including subject catalogues, indices, bibliographies, and previous research.

In an effort to focus upon broad trends, primary sources were selected based upon their discussion of issues at the national level, especially published primary sources. Useful primary sources included accounts of military personnel with exposure to several installations, published works by prominent officials, and professional magazines or publications.

Congressional documents provided the richest source of information linking the evolution of the services to the physical development of installations. Congress maintained an intense interest in the armed forces, and often insisted upon detailed statements from the military services. The *Annual Reports* of the Secretaries of War and the Navy were especially useful. Other useful Congressional documents included executive reports to Congress and published hearings. All but the hearings are available on microfiche through the Congressional Information Service Serial Set. Hearings are available as separately published works, in the Library of Congress.

Several record groups at the National Archives provided valuable historic maps, building plans, and building records. Pre-1940 maps were reviewed for each of the seventy-five installations selected for site visits, in order to understand the development of the installations (Records of the Office of Chief of Engineers, RG 77, Fortification File; Records of the Office of the

Quartermaster General, RG 92, Blueprint File, Railroad Blueprints; and, Records of the Bureau of Yards and Docks, RG 71). Standard Quartermaster plans for Army posts were examined to identify typical construction, while installation completion reports provided exact descriptions of what actually was built.

Research was conducted at the Library of Congress, in Washington, D.C., and at the National Archives Cartographic Branch, Alexandria, Virginia. Other repositories consulted included: the National Archives, Washington, D.C., and Suitland, Maryland; Military History Institute, Carlisle Barracks, Pennsylvania; Quartermaster School Historian's Office, Fort Lee, Virginia; Naval Institute, Annapolis, Maryland; Air and Space Library, Smithsonian Institution, Washington, D.C.; Federal Aviation Administration Library, Washington, D.C.; Navy Department Library, Washington Navy Yard; and, U.S. Army Center of Military History, Washington, D.C.

The literature search also identified previous cultural resource investigations related to the current project. Repositories consulted included State Historic Preservation Offices, the National Register of Historic Places, and the Historic American Building Survey and the Historic American Engineering Record. These cultural resource studies provided basic information on previously identified historic properties that assisted with the extrapolation of the categories and types of real property associated with the chronological and topical studies.

Field Investigation

Site visits to seventy-five active-duty DoD installations were undertaken to examine a sample of the DoD inventory of pre-1940 real property. These field investigations were used to verify the range of property types anticipated from the archival research, to assist in development of guidelines for assessing the integrity of examples of property types, and to collect data on existing pre-1940 military construction, thereby enabling comparative analyses. Installations were selected, in consultation with the U.S. Army Corps of Engineers and with the DoD Legacy Program, based on the following criteria: (1) known or anticipated concentrations of resources constructed prior to 1940; (2) geographic distribution; (3) type of installation (e.g., shipyards, arsenals, depots, fortifications, hospitals, etc.); (4) period of development; and, (5) distribution among the Army, Navy, Marine Corps, and Air Force. The information collected during the site visits included previous cultural resource reports, reconnaissance-level survey data, photographs of representative building types, and current maps. These data were incorporated into the historic context. Maps of each installation, indicating areas within the installation that contain concentrations of pre-1940 structures, were produced at 1:800 scale using computerizing mapping software (Autocad or Intergraph).

Data Synthesis

Data collected during the course of the first two tasks were correlated, analyzed, and synthesized in accordance with the organizational framework established in the research design. Draft historic overviews and theme studies were submitted to the history offices of the respective services for review. This interim review served to ensure the accuracy and completeness of the draft overview, and to identify areas of further investigation. The review comments of the respective services were addressed in the preparation of this report.

The property types framework, which was derived from analysis of the National Register's functional categories and from review of previous cultural resource surveys of military installations, was refined on the basis of the results of the field surveys. Intensive analysis of photographs was

undertaken to classify buildings by their original use, to identify character-defining features, and to establish patterns of military construction.

Finally, the overview, theme studies, property types, and installations were cross-referenced, so that their inter-relationships could be examined. Simple matrices provided the format both for analysis and for presentation of summaries of the results of data synthesis.

Context Application

To illustrate the application of the context in the nomination process, National Register documentation was prepared for four installations. Pensacola Naval Air Station was selected to illustrate the evaluation of a facility that possessed significance within more than one historic context. Langley Air Force Base was documented as an installation that may meet National Historic Landmark criteria, both for its pivotal role in the development of early military aviation and based on its design by the nationally-prominent architect Albert Kahn. Ft. Monmouth was chosen as the third nomination case study because of its role in the development of military communication, one of the specific themes developed in the Military Historic Context. Ft. McPherson was the fourth site selected; it illustrated the amendment of an existing National Register nomination to include data from the National Military Context.

Report Organization

The report is presented in four volumes, organized into five major divisions reflecting the research design of the project. Preceding the body of the report are an *Introduction* to the project, which describes its purpose, methodology, and organization, and a section on the *Application of the National Historic Context*, which explains the practical use of this study in the identification, evaluation, and treatment of historic property. *Introductions* to each of the five major divisions of the context provide additional guidance for its application. The major divisions of the National Military Context are:

- *Part I* - *Chronological Overview*
- *Part II* - *Theme Studies*
- *Part III* - *Property Types*
- *Part IV* - *Installation Site Reports*
- *Part V* - *National Register Nomination Case Studies.*

Project Background

The *National Context for Department of Defense Installations, 1790 - 1940* is a demonstration project (Demonstration Project #75) funded by the DoD Legacy Cultural Resource Program. The Legacy Program was created by the Department of Defense Appropriations Act, 1991 (P.L. 101-511). The purpose of the Legacy Program is:

> To better integrate the conservation of irreplaceable biological, cultural, and geophysical resources within the dynamic requirements of military missions. To achieve this goal, the Department of Defense will give high priority to inventorying, conserving, and restoring biological, cultural, and geophysical resources in a comprehensive, cost-effective manner in partnership with federal, state, and local agencies and private groups.[2]

The lessons and data derived from demonstration projects are designed to be incorporated into the DoD cultural resource management program, and then applied to the on-going mission of cultural resource stewardship.

R. Christopher Goodwin & Associates, Inc. completed this project on behalf of the Department of Defense, under contract to the U.S. Army Corps of Engineers, Baltimore District. The project research design was developed in consultation with the U.S. Army Corps of Engineers, Baltimore District, and the DoD Legacy Program.

NOTES

1. U.S. Department of the Interior, National Park Service, "Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines," *Federal Register*, Vol. 48, No. 190 (Thursday, September 29, 1983).

2. U.S. Department of Defense, Office of the Assistant Secretary of Defense for the Environment, *Legacy Resource Management Program*, Report to Congress, September 1991, 3.

INTRODUCTION TO PART I - CHRONOLOGICAL OVERVIEW

The *National Historic Context for Department of Defense (DoD) Installations, 1790 - 1940* is a Legacy Program demonstration project designed to assist the Department of Defense (DoD) in executing its responsibilities for cultural resources under the National Historic Preservation Act of 1966, as amended, applying the Secretary of the Interior's Standards for Preservation Planning and the guidelines of the National Register Program. The purpose of the project is to examine the complex historical and architectural relationships among DoD construction on a nationwide basis to provide comparative information on the historic significance of military construction in the contiguous United States between 1790 and 1940.

The National Military Context integrates the three components of an historic context - time period, geographic area, and theme. The overall study is organized into five sections:

Part I - Chronological Overview;
Part II - Theme Studies;
Part III - Property Types;
Part IV - Installation Site Reports; and,
Part V - National Register Nomination Case Studies.

Part I - Chronological Overview is presented in the following section and provides a synthesis of American military history from 1790 to 1940. This synthesis is divided into four chronological periods that correspond to major historical periods:

- Chapter 1: The Military in the Early Republic and Antebellum Era, 1790-1860;
- Chapter 2: The Civil War and National Expansion, 1860-1890;
- Chapter 3: The Military and the Progressive Era, 1890-1918; and,
- Chapter 4: The Inter-war Years, 1918-1940.

Each chronological period is subdivided into discussions relevant to the individual service branches; events and trends of particular importance to military construction are highlighted. These important events and trends are developed in greater detail as narratives under Part II - Themes.

The *Chronological Overview* and *Theme Studies* are cross-referenced in the accompanying matrix (Table I-1). The matrix provides the reader with a reference tool to identify themes in *Part II - Theme Studies* of particular importance within a specific period of military development. The matrix included in the introduction to *Part III - Property Types* cross-references the chronological periods of development with the property types (Table III-1). Each installation site report in *Part IV - Installation Site Reports*, lists chronological periods of development relevant to that installation. This provides comparative, site-specific examples of installations related to the various chronological periods identified in the context.

TABLE I-1.

INDEX OF CHRONOLOGICAL OVERVIEW AND THEMES.

CHRONOLOGICAL OVERVIEW

THEMES		1790 - 1860								1860 - 1890										1890 - 1918																		1918 - 1940									
		Army					Navy and Marine Corps			Army							Navy and Marine Corps				Army								Navy								Marine Corps				Army				Army Air Corps			Navy		Marine Corps	
		Frontier Forts East of the Mississippi	Frontier Forts West of the Mississippi	Coastal Fortifications	Arsenals and Armories	Education and Training	Naval Yards and Stations	Hospitals and the Naval Observatory	Marine Corps	Civil War	Frontier Posts	Coastal Defense	Ordnance Department	Quartermaster Depots	Signal Corps	Education	Results of the Civil War	Beginnings of Naval Modernization	Changing Roles of Shore Installations	Marine Corps	Army Operations	Closing the Frontier and Consolidating Posts	Coastal Defense	Development of Professional Education and Training	Development of Logistical Functions	Wartime Cantonments	Beginnings of Army Aviation	World War I Army Aviation	Steel Ship Construction and Repair	Development of Naval Ordnance	Logistical Support to the Fleet	Officer Education and Recruit Training	Personnel Support	New Technology: Submarines, Aircraft, and Radio	World War I Navy Construction	Ships Complements	Foreign Intervention	Installations and Schools	World War I	War Planning and Institutional Development	Installation Improvement	Training, Coastal Defense, Schools, and Logistics	Towards a Separate Air Force	New Construction of Air Corps Installations	Air Corps Training and Logistical Support	War Plans and the Shift to the Pacific	Submarines and Aviation	Amphibious Warfare and Marine Corps Aviation	Marine Corps Installations
Communications	Early Communications						●																																							
	Military Telegraphy and the Development of the Army Signal Corps									●	●				●																															
	Navy Wireless Communications during the Twentieth Century																																●													
	The Army Signal Corps during the Twentieth Century																									●	●																			
Education	Military Education in the Early Republic					●	●																																							
	Beginnings of Military Professionalism														●				●																												
	Military Education during the Progressive Era and World War I																						●		●							●			●			●	●							
	Military Education between the Wars																																									●		●	●			●
Medicine	Military Medicine in the Early Republic	●	●					●																																						
	Civil War and National Expansion									●	●																																			
	Military Medicine during the Progressive Era																				●			●		●																			
	Military Medicine during the Inter-war Years																																										●	●		●		
	Women in Military Medicine									●											●					●																			
Planning and Architecture	Coastal Fortifications			●																																									
	Early Frontier Posts	●	●								●																																			
	Industrial Eclecticism: Ordnance Facilities and Shipyards				●		●					●							●	●																									
	Consolidation and Modernization: The Trans. from Eclecticism to Beaux Arts																	●				●		●						●	●	●				●									
	World War I: Temporary and Permanent Construction																									●		●						●	●				●						
	Inter-war years: Regional Architecture and Community Planning																																								●		●		●	●		●
Technology	Weapons and Ammunition				●		●			●			●				●	●							●							●								●		●					
	Fortifications			●						●		●											●																	●		●					
	Warships						●											●											●		●		●	●												
	Military Aircraft																										●	●					●										●	●	●		●	●
Trans-portation	Military Contributions to Transportation Development	●	●				●		●																	●	●	●				●										●				
	Benefits of Transportation Systems to the Military	●	●							●	●										●	●				●									●									●		

CHAPTER 1
THE MILITARY IN THE EARLY REPUBLIC AND ANTEBELLUM ERA, 1790 - 1860

Even as they organized a Federal government, the people of the United States demonstrated a combination of suspicion and apathy towards a military establishment. In addition to a reluctance to pay taxes in support of the military, a large portion of the population believed that a standing military establishment was a threat to republican government. Moreover, the generally isolated location of the United States appeared to make a large military unnecessary. The effects of this attitude are apparent in the virtual dismemberment of the military following the Revolution, the debates about a standing Army during the Constitutional Convention, and in the continued meager appropriations for the Army and Navy.

Yet events soon demonstrated the need for at least a small military. Indians threatened settlers on the frontier, and pirates preyed upon American commerce abroad. More importantly, a prolonged war between France and Britain endangered the American position as a neutral nation. The United States first entered an undeclared war against France, called the "Quasi-War" of 1798-1799, and then against England in the War of 1812. Americans realized that they needed an Army strong enough to police the frontier and to defend the coastline. They needed a Navy that could protect American commerce, and counter the British and French navies on the ocean and the Great Lakes.

Throughout this time period, Americans displayed this ambivalent attitude towards the military. They recognized the necessity of an Army and Navy to protect the expanding interests of the nation, yet they also remained reluctant to spend money on the military, or to enlarge the military beyond what strictly was necessary.

The history of Army and Navy installations reflects this attitude. Most construction projects, especially in the frontier, consisted of crude, temporary structures. Permanent installations, such as coastal fortifications or Navy yards, grew very slowly during these years.

Army

With the close of the American Revolution, the Continental Congress drastically reduced the size of the Army. Even after the adoption of the U.S. Constitution, the Army remained at its minuscule strength until Indian troubles in the vicinity of what is now Ohio caused Congress to authorize the re-establishment of the Army. For the remainder of this period, the Army divided its attention between policing the frontier regions and defending principal harbors. Its peacetime total strength did not exceed 10,000 until 1840, and only reached 15,000 in 1855. Given the fact that the nation was at peace and isolated from Europe, this small size sufficed for the needs of the nation.

Army installations of the early republic and antebellum eras reflected the nature of the Army's missions. The early installations can be divided into four categories: (1) the frontier posts, which normally moved with the shifting frontier; (2) a series of coastal defense fortifications at strategic harbors; (3) arsenals and armories; and, (4) education and training installations. Frontier garrisons, despite their crucial role in opening the territories, were normally primitive installations, whose architecture reflected congressional demands for economy. Coastal fortifications were better designed than frontier forts and were built to be permanent. Yet the slow speed of their construction also indicated congressional reluctance to pay for military projects.

Frontier Forts East of the Mississippi

The first substantial force authorized by the new government was an infantry regiment of just over 1,200 men, organized in 1790. When this force proved insufficient, Congress authorized a second regiment. Under the inept command of Arthur St. Clair, the Army suffered a disastrous defeat from the Indians in the old Northwest Territory. Congress then made another attempt at creating a Regular Army with the authorization of a "Legion," this time commanded by "Mad" Anthony Wayne. Wayne proved to be a more competent general, who thoroughly trained his forces, and then defeated the Indians at Fallen Timbers in 1794. This organization formed the basis of a permanent Army and foreshadowed the Army's role as an Indian fighting force during the nineteenth century.

Frontier forts reflected the primitive character of service in the territories. With a few conspicuous exceptions, they were intended to be temporary structures, constructed by the labor of the soldiers, at minimum cost. Even though frontier forts were often located at strategic points, they usually were far from the mainstream of the American economy. Consequently, they became self sufficient to the maximum extent possible.

From the beginning of the republic through the War of 1812, the British continued to exert a disruptive influence on the Indians in the old northwest. Prior to Wayne's victory at Fallen Timbers, the British maintained a presence within United States territory and encouraged Indian warfare. Even after that battle and the Indian concessions in the Treaty of Greenville, the British in Canada maintained their friendly relations with the Indians. The increasing number of settlers still required government protection. Consequently, the War Department endeavored to protect this region by directing the construction of strong points at strategic locations along the Great Lakes and the major rivers. Some of the most notable examples of forts constructed during this time include Ft. Dearborn (now Chicago), Ft. Detroit, and Ft. Wayne.

Because of the threat of attack, these posts were true forts in the sense that each contained a palisade and a blockhouse. Barracks, officers' quarters, and storehouses were enclosed within the fortifications. During the War of 1812, however, these defenses proved to be of little value. The commander of Ft. Dearborn surrendered the garrison with no resistance.

Following the War of 1812, the danger from Indians diminished, but did not disappear, especially in the Indiana and Illinois territories. The British still possessed Canada, and were suspected of dealing with the Indians. Moreover, the possibility of another war with Britain remained. Therefore, the Army continued to fortify the northwest frontier. Ft. Dearborn was reoccupied in 1816. More importantly, the War Department directed the construction of a new series of fortifications along the upper Mississippi Valley. In Wisconsin, where the Fox and Wisconsin rivers formed an important waterway between the Mississippi River and the Great Lakes, the Army built new forts at both ends and in the middle of the waterway. It also built Ft. Snelling at the confluence of the Minnesota and Mississippi rivers, and Ft. Armstrong at Rock Island in the Mississippi. On the Great Lakes, the Army built Ft. Brady on the straits at Sault Ste. Marie. Ft. Michillmackinac on the straits between Lake Michigan and Lake Huron had been an American fort since 1796.

Like the pre-war fortifications, these forts originally were constructed to withstand a hostile attack. Yet with the passage of time, the danger of a direct attack on the forts receded. Euro-Americans began to outnumber the Indians, who were reluctant to attack an Army post without British support in any case. Although relations with Britain were never entirely friendly, the end of the Napoleonic Wars removed a major source of friction and the Webster-Ashburton Treaty further eased relations. The posts became more like garrisons than fortifications. Gradually the palisades and blockhouses disappeared; instead, the soldiers constructed brick or frame quarters.

The installations also acquired workshops, storehouses, gristmills, sawmills, and similar indications of civilization.

As their amenities increased, the frontier forts in the upper Mississippi lost their value as defensive positions. They became locations for quartering troops, who could be dispatched to trouble spots. Initially, officers and observers had difficulty understanding the transition from fortification to garrison, as the Inspector General George Croghan complained:

> Why this place [Ft. Brady] is dignified with the name of fort I can not imagine, for it is fitted for neither offensive or defensive purposes. So badly is it designed for either that in the event of an attack the danger of troops composing its garrison would be lessened only when they had gained the open spot without the line of pickets[1].

Croghan's complaints notwithstanding, these garrisons suited their purpose. The presence of soldiers served to keep peace with the Indians.

Ft. Snelling, first constructed in 1819 at present-day Minneapolis, is a good example of the transformation of fortifications into comfortable living quarters. Its second commander, Colonel Josiah Snelling, set about to erect permanent, stone buildings, surrounded by an elaborate stone wall, with watchtowers. Inside the walls were spacious living quarters and administrative buildings. Yet a skeptical observer doubted the utility of the walls. Although the fort was stronger than necessary for an Indian attack, it could not withstand an attack by a conventional Army, because it was located half-way up the bluff. The observer then noted that, "The idea is further suggested, that the strong stone wall was rather erected to keep the garrison in, than the enemy out."[2]

During the lengthy interlude between the War of 1812 and the Mexican War, soldiers' time was increasingly occupied by non-military pursuits. Construction and repair of the posts were among the most prominent of these extra duties. Soldiers also became expert farmers in an effort to reduce the costs of feeding the Army. Traditionally, each post had its own vegetable garden to supplement rations of salted meat and bread. From 1818 to 1833, however, soldiers tilled elaborate grain fields, and raised their own livestock. When not employed in agricultural or military pursuits, troops often were used to construct roads and bridges. One disenchanted enlisted man complained:

> I am deceived; I enlisted for a soldier; I enlisted because I preferred military duty to hard work; I never was given to understand that the *implements of agriculture and the mechanic's tools* were to be placed in my hands *before I had received a musket or drawn a uniform coat.* ... I enlisted to avoid work, and here I am, compelled to perform three or four times the amount of labor I did before my enlistment.[3]

The Army also maintained a smaller presence in what was then southwestern regions. For the most part, the Army garrisoned the lower Mississippi Valley, in what is now Louisiana, Arkansas, and Oklahoma. Jefferson Barracks, located near St. Louis, formed the hub of the Army presence in this region. With the outbreak of the Second Seminole War in 1835, a large portion of the Army moved to Florida, and there constructed a variety of temporary camps or blockhouses.[4]

Frontier Forts West of the Mississippi

As the population began to cross the Mississippi, the Army also played a key role in the exploration and settlement of these vast regions. Meriwether Lewis and William Clark in 1804 - 1806, and Zebulon Pike in 1805 - 1807 led exploration expeditions of the Trans-Mississippi West. Throughout the antebellum era, Army Topographical Engineers, such as Stephen Long and Gouverneur Warren, continued to map the western plains.

During the 1840s, American pioneers traveled through the Great Plains in their movement to Oregon Territory and California. Merchants established overland trade routes to Santa Fe, in what was then part of Mexico. As a result, the plains regions were crossed by a set of overland trails: the Oregon Trail, the California Trail, and the Santa Fe Trail. As settlers moved across the comparatively empty regions, they required military protection. As the United States acquired title to this land, the Army assumed responsibility for protecting the overland trails.

Beginning with Ft. Atkinson in 1819, located on the Missouri River in present-day Nebraska, the Army established garrisons along the most traveled western routes. In time, the Army created a series of forts along the major westward trails. Posts along the Oregon Trail included Ft. Kearny (created in 1846), Ft. Laramie (acquired in 1849), and Ft. Bridger (acquired in 1857). Ft. Riley was established in 1853 to protect traders and settlers traveling along the Oregon and Santa Fe Trails. In 1827, the Army abandoned Ft. Atkinson, Nebraska, and replaced it with Ft. Leavenworth, Kansas. In 1850, it built another Ft. Atkinson in Kansas.

With the annexation of Texas in 1845, the Army established a string of fortifications extending through the Texas hill country and along the Mexican border. Shortly after the annexation of Texas, the United States entered into a war with Mexico that lasted from 1846 to 1848. Although the Army had not fought a conventional war since 1812, it performed well in this conflict. General Zachary Taylor defeated numerically superior Mexican armies along the Texas border. Winfield Scott led a difficult overseas expedition that captured the port of Vera Cruz and he then marched to Mexico City, thus forcing the surrender of Mexico. As a result, the United States acquired what is now the southwestern United States. The Army, which had returned to its peacetime strength levels, now had the added responsibility of keeping peace between settlers and Indians in the new territories.

Conditions in the trans-Mississippi region required more mobility than infantry soldiers could provide. In 1833 and 1836, Congress re-established mounted units, the 1st and 2nd Regiments of Dragoons. In 1846, Congress authorized a Regiment of Mounted Riflemen, followed by two cavalry regiments in 1855. Like other Army regiments, the mounted regiments were scattered throughout the west in small units. After the Civil War, all mounted units would be termed cavalry, even though they more often operated as dragoons. That is, they used horses for transportation, but dismounted and fought as infantry during combat.[5]

The typical fort in the trans-Mississippi region was organized around a parade field, with the enlisted barracks and officers' quarters facing the parade ground (Figure I-1). Other administrative buildings or shops were located behind the living quarters. Most posts contained a headquarters building, a blacksmith shop, stables, and a corral. Some forts contained defense works, such as palisades or blockhouses, but most were relatively open.[6]

Living conditions in frontier garrisons were infamously bad. With the Army spread so thinly over a vast territory, few posts contained more than two companies, and many contained only one company. These forts usually were far removed from any established sources of supply, therefore, soldiers were compelled to build their own shelters, using whatever material was readily available. They often constructed barracks from unhewn picket logs. Visitors reported that

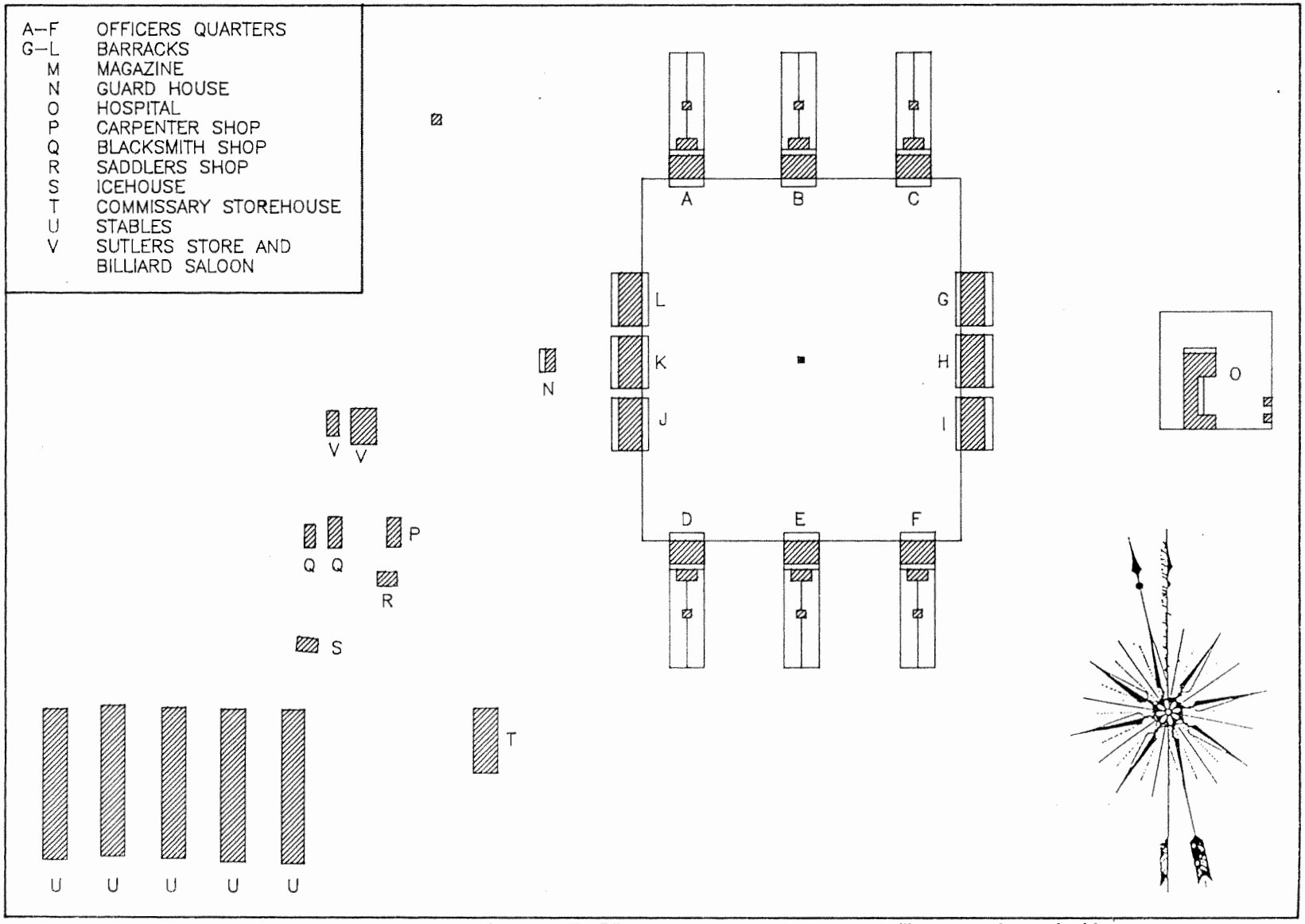

Figure I-1. The original ground plan of Ft. Riley, Kansas, built 1854 - 1859, illustrates the typical layout of western frontier posts, with housing around the parade field and separate areas for the hospital, shops, and stables. (Based on Ground Plan of Ft. Riley, Kansas, 1867, National Archives, RG 77, Drawer 29)

soldiers would sleep outdoors whenever possible in order to avoid the rats and vermin that inhabited the barracks walls.[7]

The dispersion of the Army across isolated garrisons enabled officers to indulge in eccentric behavior. One such example occurred when First Lieutenant Braxton Bragg was a company commander, with additional duty as the post quartermaster. The historian Edward Coffman described what followed:

> As company commander he made a requisition. As Quartermaster, he declined to fill it and explained his reasons in a written endorsement. Acting as company commander, he promptly rebutted these arguments but, as quartermaster, he was adamant in his refusal. After he heard of the problem, Bragg's post commander exclaimed, "My God Mr. Bragg, you have quarrelled with every officer in the army, and now you are quarreling with yourself!"[8]

Other problems, including widespread alcohol abuse, were not so amusing; yet they persisted throughout the nineteenth century. The distribution of the Army into such small garrisons was an important contributing factor to this lack of centralized control. It was extremely difficult for Army leaders to control their subordinates over such distances, and the monotony of garrison life could magnify personality problems.

Coastal Fortifications

A second mission of the Army, that of protecting the United States from foreign attacks, led to the creation of a series of harbor fortifications. These harbor fortifications occupied a prominent place within the antebellum Army, and left a physical legacy of impressive masonry structures.

Although some harbor defenses had existed since the colonial period, the Army's systematic improvements began in 1794, as the war between France and Britain threatened to involve the United States. The beginnings of harbor defenses were modest, with a budget of only $76,053.00. Most of the defenses authorized in this act were merely earthworks, with as few as eight artillery pieces to defend some of the smaller ports. Yet the act also authorized some masonry and earthworks fortifications, most notably Ft. McHenry in Baltimore. This so-called "First System" was so under-funded that it proved to be inadequate.[9]

With the threat of war increasing after a battle between British and American ships, known as the *Chesapeake* incident, Congress in 1807 authorized another construction project for coastal fortifications, known as the "Second System." Architecturally, this system did not differ significantly from the preceding system. It also contained a number of structures that were entirely earthworks, with some other forts that contained earth ramparts held in by masonry.[10]

After the War of 1812, the nation began devoting serious attention to the subject of coastal fortifications. The embarrassing destruction of Washington, with the concurrent successful defense of Baltimore by Ft. McHenry, pointed to the potential value of well-designed fortifications. Because an invading enemy normally required a port to sustain operations, defense of the most important harbors would largely secure the coastline. The Third System of coastal fortifications was designed to protect important harbors and cities, interior navigation, and navy yards.

Without the urgency of a specific threat, coastal defense under the Third System grew slowly and carefully. For the Army this slow speed had mixed effects. On one hand, the meager appropriations for construction frustrated engineers and artillery officers. From 1831 to 1835, for

example, appropriations for Ft. Monroe continually decreased until no money was appropriated in 1834. After more than 40 years of construction, the Third System was nearing completion by 1860.[11] On the other hand, the lack of urgency allowed the War Department, especially the Corps of Engineers, to plan a system with due care. In 1816, the War Department established a board of engineers, whose most prominent members were Simon Bernard and Joseph G. Totten, to develop a comprehensive plan. Members of the board visited harbors to be fortified and selected positions that afforded the best coverage of harbor entrances. Where two or more forts defended the same harbor, the board integrated the defensive network.[12]

One of the most important developments of the Third System was the use of all-masonry fortifications, rather than the combination of earth and masonry that characterized earlier structures (Figure I-2). The use of masonry allowed the engineers to construct casemates, or gun portals within the walls. Although primarily intended to protect the gunners during an attack, casemates also allowed engineers to multiply the number of guns at a single fort by placing tiers of guns inside the walls. Thus, this new series of forts could produce a formidable array of firepower.[13]

Casemates were not so welcome, however, to the soldiers assigned to coastal forts. With few exceptions, the Corps of Engineers did not build barracks at these forts. During the 1820s, this responsibility was assigned to the Quartermaster Department, which also did not build suitable quarters. As an expedient solution, soldiers were housed inside the casemates, despite the cold, damp, dark atmosphere. Continued protests against this arrangement notwithstanding, casemates were used for shelter well into the post-Civil War era.

An 1836 report to Congress listed 38 coastal fortifications, with an average of 70 guns per fort. Ft. Monroe (Hampton Roads, Virginia) was the largest of these forts with 301 guns, with Ft. Adams (Newport, Rhode Island) second largest at 293 guns, and Ft. Pickens, (Pensacola, Florida) third at 235 guns. Most forts contained between 15 and 100 guns, although forts guarding the smaller cities might be fortified with less than 10 guns. Ft. Hale (New Haven, Connecticut) was the smallest on the list, with only 6 cannons. Sixteen of the forts contained casemated guns, while the remainder only mounted guns on the ramparts (barbette guns).[14]

Based on the number of soldiers assigned to coastal fortifications, the coast defense mission rivaled frontier duty in importance during the period between the War of 1812 and the Mexican War. An 1827 report listed 2,407 officers and enlisted men assigned to the Eastern Department, most of whom were stationed along the Atlantic and Gulf coasts. The Western Department contained 2,906 officers and men.[15]

Arsenals and Armories

Of the special purpose installations, those operated by the Ordnance Department were the most numerous. The Ordnance Department was created by an act of Congress in 1812, following the unsuccessful efforts to purchase military supplies through the Treasury Department. In 1815, Congress further refined the duties of the Department; but from 1821 to 1832, Congress consolidated the Ordnance Department with the Artillery. When the Ordnance Department was reconstituted as a separate agency in 1832, it had 14 officers and 250 enlisted men.[16]

The armories at Springfield, Massachusetts, and Harpers Ferry, Virginia (now West Virginia), manufactured and repaired small arms, primarily muskets and rifles. Springfield Armory had been an ordnance depot since the Revolution. In 1794, Congress authorized the acquisition of Springfield as an armory, and simultaneously authorized the acquisition of Harpers Ferry. Although both armories pioneered the use of standardized parts, Springfield was an important pioneer in the standardization of industrial techniques.[17]

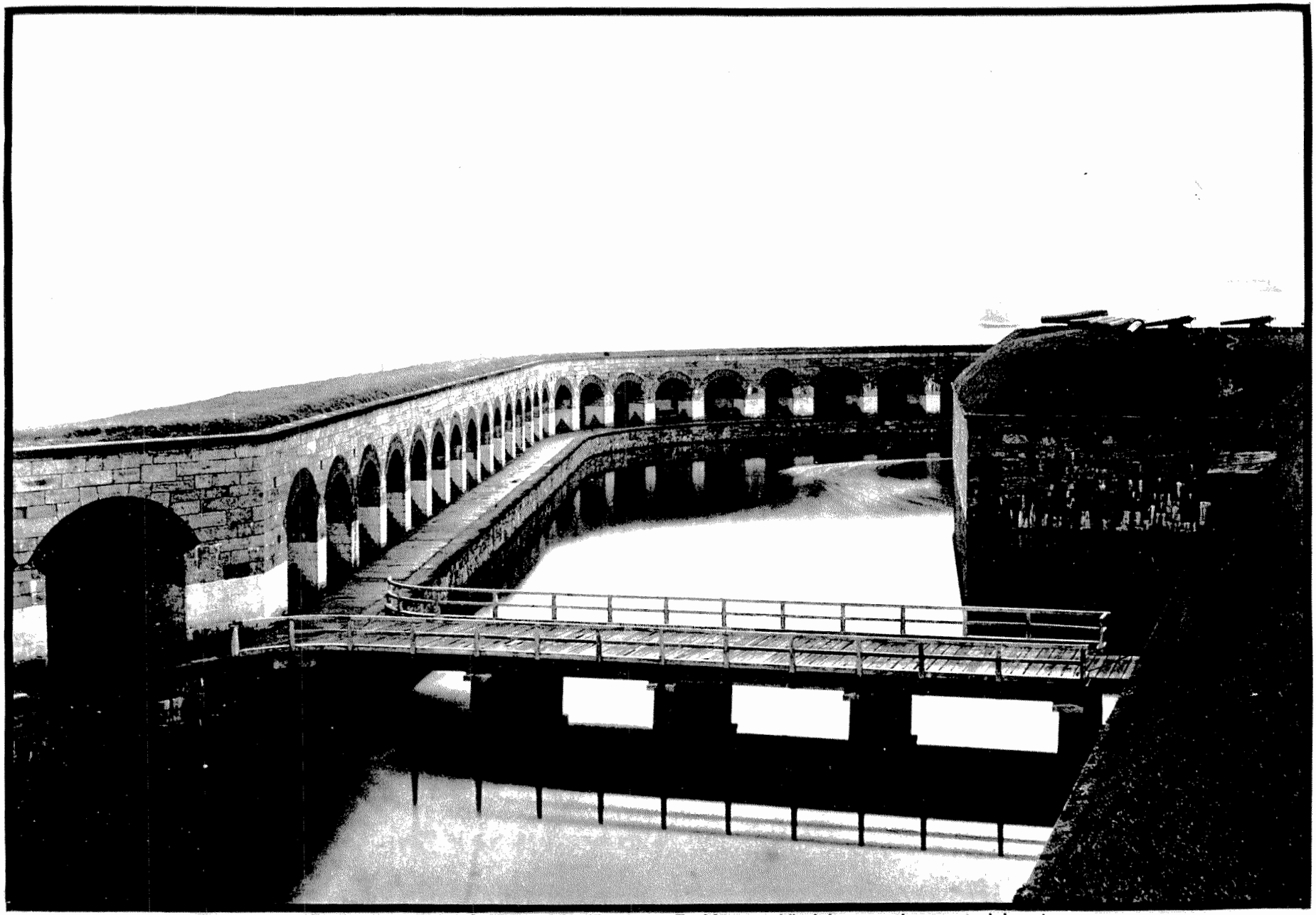

Figure I-2. Of all of the Third System of fortifications, Ft. Monroe, Virginia, was the most elaborate. This nineteenth-century photograph depicts the Water Battery. (Courtesy of the Military History Institute)

The Army also built smaller ordnance installations called arsenals, beginning with the Schuylkill Arsenal in 1799. In 1849, there were 28 arsenals, which were divided into arsenals of construction, arsenals of deposit and repair, and depots. The four arsenals of construction were located at West Troy, New York (Watervliet), Pittsburgh (Allegheny), Washington, D.C., and Hampton, Virginia (Ft. Monroe). They fabricated the varied types of military equipment other than weapons, such as gun carriages, caissons, armorer's tools, ammunition, and gunner's haversacks. The arsenals of deposit and repair fixed ordnance stores, including small arms; they also stored and maintained ordnance supplies for future issue. The ordnance depots could only perform minor maintenance; they were primarily storage facilities.[18]

Education and Training

The very few schools within the Army constituted a minor category of installations. The Military Academy at West Point was the most important educational institution within the War Department at that time. Ft. Monroe was not only the largest coastal fortification, it was also the site of the Artillery School of Practice, the Army's first service school.

By the 1850s, the Army developed a system of recruit depots to introduce new soldiers to the Army. Mounted soldiers (dragoons or cavalry) were sent to Carlisle Barracks, while infantry or artillery were sent to Ft. Columbus (Governor's Island), New York, or Newport Barracks, Kentucky. At the recruit depots, they received minimal training before being sent to a unit. New soldiers were not assigned to a recruit depot for a specified time; rather, they remained until a requisition arrived from a western post. Moreover, there was no set training program. Instruction tended to be irregular, and soldiers were expected to learn most of their duties in their unit.[19]

Navy and Marine Corps

Following the close of the Revolution, the Navy also had been allowed to dissolve. During the first years of the new republic, Americans did not see the need for a navy. Yet in the latter 1790s, France and Britain began a protracted war that threatened to involve the United States. Pirate attacks upon American commerce in the Mediterranean and Caribbean further accentuated the need for a navy. In response, Congress authorized the construction of six frigates in 1794. In 1798, it established the Navy Department and the Marine Corps.

Like the Navy that it served, the antebellum shore establishment appears relatively simple by today's standards. Yet the Navy Department could build, repair, and resupply its fleet with its collection of yards and stations. The limited naval technology of the nineteenth century did not require greater sophistication.

Naval Yards and Stations

When Congress authorized six frigates, it did not authorize acquisition of shipyards to build and repair these ships. Consequently, Secretary of the Navy Benjamin Stoddert purchased the first yards out of funds appropriated for the construction of ships. He justified this action by arguing that the result of this omission proved to be more expensive than acquisition of the yards:

> No express provision was made by Congress for establishing navy yards for building the first six frigates directed by law. But as vessels so large cannot be built without first erecting wharves, or extending wharves before erected, both these things were done, and in every instance on private property; so that the

> public have now little or no advantage from the expenditure of sums to a considerable amount. The evil, however, did not stop here. The yards connected with the wharves were, in almost every instance, too confined to admit of the convenience of piling away the timber in a manner to prevent the necessity of frequent removals of one piece to get at another, which happened to be first wanted. The expense of this unnecessary kind of labor, arising solely from the want of sufficient room in the yard, amounted to several thousand dollars in building the frigate United States at Philadelphia. At Boston and Baltimore, there is reason to believe this expense was still more considerable. . . .
>
> But when the building of these frigates commenced, it was not foreseen that the United States would so soon want more; nor was the public mind prepared to consider the establishment of a navy as necessary to the honor and safety of the country. . . .
>
> In view of the subject, and believing that it is the truest economy to provide at once permanent yards, which shall be public property, and which will always be worth to the public the money expended thereon, . . . the Secretary of the Navy has had but little difficulty in making up his opinion that the proper course to be pursued is, to make the building yards at Norfolk, Washington, New York, and Portsmouth public property, and to commence them on a scale as if they were meant to be permanent. And also, the building yards at Philadelphia and at Boston, notwithstanding the high prices which must be given for the ground.[20]

By 1802, a congressional committee noted the Navy had acquired six yards and had commenced improvements upon them. These yards were at Washington, D.C.; Portsmouth, New Hampshire; Charlestown (Boston), Massachusetts; New York (Brooklyn), New York; Philadelphia, Pennsylvania; and Gosport (Norfolk), Virginia.[21]

The expanding needs of the nation caused the Navy to establish four more yards that remained in service throughout the antebellum period. The possibility of another war with Great Britain resulted in the creation of a small yard at Sacketts Harbor on Lake Ontario in 1809. In 1825, the Navy built a yard in Pensacola, Florida, to support operations against Caribbean pirates. In 1843, the Navy responded to congressional pressure to construct a yard along the Mississippi River and built a yard in Memphis, Tennessee. With the acquisition of California after the Mexican War, the Navy built a yard on the Pacific Coast in 1853, at Mare Island, in San Francisco Bay.

Because of their central locations and excellent facilities, the yards at Boston, New York, and Norfolk became the most important facilities during the antebellum period. Portsmouth and Philadelphia lacked the real estate to develop into major facilities. The Pensacola and Mare Island Yards were used primarily for necessary repairs to vessels in the Caribbean and Pacific; they were too far from the American industrial base for extensive construction or repair work. The Memphis Yard contained an excellent rope-walk (a facility for winding fiber into rope), but little else.

Although the Washington Yard lacked the harbor for extensive ship repairs, it acquired other roles. A few vessels were constructed there, but the yard became more important for its production of secondary items. It was the only yard capable of fabricating marine steam engines before the Civil War, and it was the Navy's primary manufacturer of anchors. In 1820, the Navy built its first ordnance laboratory at the Washington Yard, and thereby began the installation's long association with naval ordnance.[22]

Because they served primarily to build or repair warships, the Navy yards were industrial facilities. Typical buildings included smitheries, forges, rope-walks, timber sheds, building slips,

sail lofts, and similar buildings. A large portion of the yards' employees normally were civilian workmen. The yard commandant also might be responsible for contracting with civilians for construction materials, such as rope.[23]

Two innovations of the Navy yards of this period were the ship house and the marine railway. The ship house was a huge frame building to shelter workers while constructing a ship. William Brainbridge introduced this type of structure to protect workers at the Portsmouth Navy Yard from the New Hampshire winters. The marine railway was a device for removing a ship from the water on an inclined plane. The first such device was built at the Washington Navy Yard in 1822.[24]

Dry docks constituted a major and controversial part of the more important yards. Congress had appropriated the money for building dry docks in the Boston and Norfolk Yards in 1827, and these docks were completed by 1833. To provide for greater repair facilities, Congress authorized another dry dock at Brooklyn in 1835. These docks were of the conventional "excavated" variety. That is, they were built below the water level, with heavy granite sides to offset the upward water pressure. During the 1830s, however, other engineers advocated a "floating" dry dock, which consisted of a wooden frame that could be constructed at a fraction of the cost and time of an excavated dock. Despite the Navy's expressed preference for the conventional method, Congress authorized floating docks for Philadelphia and Pensacola. In time, the greater durability of the excavated docks would demonstrate that they were more economical.[25]

Ship repairs were not the only function performed at the Navy Yards. They also served as depots for resupplying ships. Extracts from the Secretary of the Navy's *Annual Reports* show that the Boston, New York, and Norfolk Yards received large quantities of provisions and sundry supplies to refit ships upon their return to the United States. The extracts of contracts also indicate that the three major yards were used as distribution centers for ships stationed abroad. These extracts list contracts for transporting supplies to stations in Africa, Asia, and the Mediterranean. Other yards might also be used for resupplying vessels, but not to the same extent as the three major yards.[26]

Most Navy ships of the antebellum era were powered entirely by sail; the few ships with steam engines used them only as auxiliary power. Yet any use of steam required coal. In 1857, the Navy acquired a coaling station at Key West, Florida.[27]

Another important function of the yards was to maintain ships "in ordinary." In order to minimize costs, the Navy Department ordered that a varying percentage of its ships be removed from active service, and preserved at a Navy yard. Each yard was assigned a contingent of sail makers, carpenters, and craftsmen to perform the necessary maintenance on these ships until they were needed.

These yards also were located close to recruiting stations, and normally maintained a "receiving ship." A receiving ship was an antiquated ship, no longer fit for active service, that was permanently docked at or near a naval installation. New recruits and transient enlisted personnel were quartered on the receiving ships, and were under the jurisdiction of the ships' officers. While awaiting assignment to an active ship, the recruits were given minimal training aboard the receiving ship.[28]

The purpose of receiving ships suggests the limited functions of the antebellum Navy's shore establishment, when compared to the modern Navy. Normally, enlisted men received only minimal training before shipping aboard a warship. They were expected to learn their skills at sea. Until 1845, midshipmen also studied to be officers while at sea. In 1845, the Navy established the

Naval Academy at Annapolis, Maryland, to provide systematic education to officers before commissioning. Yet there was no systematic instruction of officers after commissioning. The antebellum shore establishment performed the limited functions of building, repairing, and supplying Navy ships.

Normally, the Navy Department provided housing for the yard commandant, and for other key officers. The department believed that the presence of these men at the yard at all times would be beneficial for the general security and operations of the yard. The Navy did not, however, provide quarters or amenities for the families of officers and men serving at sea.

Hospitals

Another type of Navy installation began with the Marine Hospital Fund. This fund first was created in 1798 to benefit merchant sailors, who would otherwise lack medical care. In 1799, Congress expanded this fund to include officers and enlisted men of the Navy and Marine Corps. In 1811, Congress separated the two funds to create a distinct Navy Hospital Fund, which required the contribution of 20 cents per month from officers and enlisted men of the Navy and Marine Corps. The Marine Hospital Fund continued to provide for merchant sailors, and became the U.S. Public Health Service in 1902.[29]

Although the Navy Hospital Fund was authorized in 1811, little progress was made in building Navy hospitals until the 1820s. In that decade, the Navy began to acquire land for hospitals near its yards at Boston, Brooklyn, Washington, and Norfolk. It also purchased the land for the Navy Asylum in Philadelphia. The Norfolk hospital was the first to receive patients in 1830.[30]

Naval Observatory

The emergence of the Naval Observatory was a conspicuous scientific achievement of the Navy during this time. The U.S. Navy began using the chronometer, a navigational instrument essential for the determination of longitude at sea, during the 1820s. Yet few ships setting out to sea had any idea whether their chronometers were accurate. In 1830, Congress authorized the creation of the Depot of Charts and Instruments in Washington, D.C., under the jurisdiction of the U.S. Navy, to maintain naval instruments and charts and to verify the accuracy of instruments through celestial observation.

Its second superintendent, Charles Wilkes, installed a telescope to test chronometers. Wilkes later commanded an exploration expedition, and the Observatory supported the expedition by conducting concurrent astronomical observations. Matthew Fontaine Maury, the superintendent from 1842 to 1861, was less interested in astronomy than practical navigation. He compiled extensive data from ships' logs to chart wind and ocean currents, producing the best navigational charts available at that time. The Observatory's charts were widely demanded by both Navy and merchant ships.[31]

Marine Corps

The U.S. Marine Corps also traces its rebirth to the so-called Quasi-War of 1798. Following the British tradition of assigning marines to warships in order to maintain discipline among sailors, Congress passed a Marine Corps Act in 1798, and authorized 33 officers and 832 enlisted men. Marines served aboard warships, primarily to maintain discipline and to suppress

mutiny among the sailors. Other functions of the Marine complements included serving on landing parties, and engaging enemy ships with musketry during close combat.[32]

The Marine Corps also protected the property at U.S. Navy yards. Therefore, each yard had its complement of Marines, with a set of Marine Corps barracks and officers' housing. Sometimes the Marines were located adjacent to the yard, such as the Marine Corps Barracks in Washington D.C. At other times, the barracks were place directly within the yard boundaries. Marines performed duties as sentinels, or other duties as directed.

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26. For example, see the Secretary of the Navy's *Annual Report* for 1845, pages 700, 780-783, 798-803, 805-811, or the 1860 *Annual Report*, 351, 354-357, 365-367.

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CHAPTER 2
THE CIVIL WAR AND NATIONAL EXPANSION, 1860 - 1890

America's armed forces began this period with one of the most catastrophic conflicts in American history, the Civil War. The U.S. Army alone grew from 16,000 to more than one million soldiers, who belonged almost entirely to volunteer units. The Navy expanded comparably as it maintained a blockade, captured Southern ports, and chased Confederate commerce raiders.

Following the Civil War, the federal government attempted to resume antebellum level of military strength. The Army returned to its frontier and coastal defense roles. Except for a few Monitor-class ironclads, the Navy maintained its fleet of wooden ships.

The Civil War left one legacy that profoundly influenced the history of the services. The federal government accumulated an enormous debt during the war, and the economic wisdom of the time dictated the rapid settlement of this debt. As a result, Congress was reluctant to appropriate any money for the military until this debt was repaid during the 1880s. Thus, the most stringent economy, including expenses for all types of installations, characterized military spending during the 1870s and 1880s.

By the 1880s, however, both the Army and the Navy could take the first steps towards the transformation into a modern military. Changes included new ships for the Navy, increased training programs for both services, and a growth of professional consciousness. The effect on Army installations was fewer posts, but with improved conditions. The Navy shore establishment grew in the number and quality of installations, as well as in the diversity of missions assigned to its installations.

Army

From 1860 to 1890, the Army gradually ended its role as a frontier constabulary and made the first tentative steps towards transforming itself into a modern military force. Though the Civil War suddenly multiplied the Army's size and forced it to depart from its Indian fighting tactics, almost immediately after the war ended, the Army reverted to its pre-war missions of frontier duty and coastal defense, with a temporary additional mission as an occupation force in the South. By the mid-1880s, the Plains Indians were largely confined to reservations, and the Army turned towards regrouping itself as a conventional military force.

The history of army posts during these years reflects these patterns. Initially, Army posts could be divided into the same three categories as the antebellum posts, i.e., frontier forts, coastal fortifications, and some special purpose facilities. Yet, with the passing of the frontier, forts that had focused on conflicts with Native Americans assumed the role of permanent garrisons, or else disappeared. Although most troops still lived on isolated posts with abominable quarters, Army leaders developed a plan for consolidating units into modern forts. New types of special purpose installations added to the diversity of Army facilities, including a proving ground, quartermaster depots, and a Signal Department installation. The Army instituted a school system that made continuing education an essential part of the professional development of officers and enlisted personnel.

Civil War

For the most part, both Union and Confederate armies sheltered their troops in temporary encampments, rather than permanent installations. Armies on the move relied on tents. Soldiers in more static situations, such as the siege of Petersburg, made crude huts of sticks and mud. At selected strategic points, both armies built fortifications from earthworks, such as the ring of forts that defended Washington, D.C.

Most of these fortifications were abandoned after the war, although the Army did maintain a few Civil War posts, such as Ft. Whipple in Arlington, Virginia (later Ft. Myer). Yet on the whole, the physical military legacy of the Civil War was far smaller than the war's impact on the nation.

The Civil War did result in the construction of Army general hospitals, hospitals intended to care for all soldiers regardless of unit. Although the Army had used general hospitals in earlier conflicts, the scale and duration of the Civil War required larger numbers of hospitals, including buildings that were designed specifically as hospitals. At first, the wounded were sheltered wherever room could be found, such as at hotels and schools. In 1862, the Quartermaster Department began to build better facilities. Later, the Army developed a "pavilion" type of hospital, which consisted of wards that were physically separated from one another and connected by corridors. Because doctors mistakenly believed that diseases were transmitted through "vapors," they believed the pavilion design would prevent the spread of disease. Even though their understanding of epidemiology was wrong, the physical separation of patients in these hospitals produced a remarkably low death rate for the time. By the close of the war, the Army had 204 general hospitals with 136,894 beds. The first pavilion-type hospital was built at Parkersburg, West Virginia, followed by hospitals at Louisville, Memphis, Chattanooga, and Jeffersonville, Indiana.[1]

Another temporary effect of the Civil War was the U.S. Army's occupation duty in the South. To shelter these soldiers, the Army relied on a variety of solutions. In Charleston, the Army occupied a former military academy, The Citadel. In Mobile, it leased land and constructed frame barracks and officers' quarters. The post of Atlanta grew into McPherson Barracks, and later Ft. McPherson, a permanent installation.[2]

Frontier Posts

After the Civil War, the American national focus turned to the settlement of the West. In 1860, the plains, mountains, and deserts between the Pacific Coast and the line of settlement extending from central Texas to Canada were populated almost exclusively by Native American tribes. The post-Civil War inundation of settlers in the West ignited the Indian Wars. The federal government's solution to the conflicts was to create reservations on which to confine Native American tribes. The U.S. Army was charged with escorting Native Americans to reservations, subduing tribes that refused to comply with the federal orders, containing the tribes on the reservations, defending white settlers, and preventing white encroachments on the reservations. By 1890, most of the West was carved into states and the native peoples were contained in reservations.

The Army resumed its mission of policing the western frontier with substantially the same resources it possessed before the Civil War. Congress authorized 10 regiments of cavalry and 25 of infantry. Two regiments of each were manned by black soldiers; these were the 9th and 10th Cavalry Regiments, and the 24th and 25th Infantry Regiments. The Army's troop strength diminished steadily from 57,194 soldiers in 1867 to a low of 24,140 in 1877, but generally remained between 25,000 and 28,000. The history of frontier forts reflected this situation. To cover such a vast territory with its small force, the Army dispersed its forces into small forts, often as small

as one or two companies. Some forts such as Ft. Abraham Lincoln in Bismarck, North Dakota, endured for comparatively long periods of time. Yet of the hundreds of forts established during these years, most were erected in response to particular problems (Figure I-3). Some posts had life spans as short as one to two years.[3]

Neither Congress nor the War Department was inclined to pay for comfortable quarters. Typically, troops constructed their own buildings with readily available materials. Where trees were available, they constructed log houses with the expectation that frame buildings might be erected later. In other areas, soldiers built adobe buildings.[4] Poor conditions may have fallen disproportionately on black units because the Army often stationed them at more remote locations, particularly in the southwest, at posts such as Ft. Huachuca, as well as at posts in the Indian Territory and in the Northern Plains.[5]

An 1872 survey of military posts by the Inspector General's office provides examples of the expedient nature of construction in the West. Perhaps the worst housing was at Ft. Whipple in the Arizona Territory. Despite the fact that this post had existed for six years in an area with plentiful pine trees, the barracks were described as "built of log pickets and mud; are generally rotten and in wretched condition." The Inspector General's report noted that although Camp Three Forks Owyhee in Idaho had been constructed within the span of six weeks, soldiers still lived in the original log buildings six years later. At Ft. Wingate, New Mexico, the soldiers lived in temporary log huts, but the report noted that new quarters, built of adobe, were being constructed. Unfortunately, the completion of new quarters was indefinitely postponed.[6] These conditions prompted Lieutenant Colonel (later Major General) George Crook to describe housing in the Department of Arizona as "unfit for the occupation of animals, much [more] less the troops of civilized nations."[7]

Colonel D. B. Sackett, the Inspector General, was even more graphic about conditions at Ft. Randall in the Dakota Territory, which he visited during an 1866 inspection tour:

> The quarters at this post are intended for six companies, all built of cottonwood logs with the exception of the set of quarters intended for the commanding officer, which is a frame building, erected at enormous expense. None of the quarters, either for officers or men, are inhabitable; they are filled with bed-bugs, fleas, rats, mice, &c. The lower logs of the quarters are rotten, and many of the buildings are falling. During the warmer months the officers move out of the quarters and live in tents, and the men sleep on the parade to avoid being devoured alive by vermin. While sitting in the commanding officer's quarters two bugs dropped from the ceiling upon me. The bed-bug is, without doubt, indigenous to the cottonwood tree. The laundress's quarters, outhouses, &c are in a dilapidated state, and not worth repairing; in fact the same remark will apply to all the quarters at the post.[8]

In 1875, the Surgeon General's office published its Circular Number Eight, or *Report on the Hygiene of the United States Army, with Descriptions of Military Posts*. This report consisted of detailed descriptions of Army posts obtained from each post surgeon. The report asserted that the crowded living conditions, contaminated water supplies, and faulty construction of quarters contributed to diseases among soldiers.[9] These criticisms notwithstanding, they had no alternative but to maintain its system of posts. The political demands for the presence of soldiers mandated widespread dispersion of troops.

Beyond the barracks, most frontier posts contained features similar to those of the western posts constructed immediately before the Civil War (Figure I-1). Normally, the enlisted barracks lined one side of the parade field, and the officers' quarters lined the opposite side. Conditions

for married non-commissioned officers varied, but often their wives were employed as laundresses, with some type of quarters allowed. At Ft. Robinson, sergeants and their wives were allowed to occupy abandoned officers' quarters. Other features included administrative buildings, guardhouses, storehouses, shops, stables, and the ever-present vegetable gardens. Most posts did not contain any palisades or other fortifications, for attacks on garrisons were rare.[10]

Beyond the terrible conditions of the quarters and buildings, officers complained that the dispersion of the Army into small units was detrimental to a unit's efficiency and discipline. Even as early as 1866, Colonel Sackett argued against small posts. "[T]hey have not enough men to send out on detached service and leave behind a sufficient force to protect the fort. The discipline of small posts is never as good as at large ones, and the fatigue duty is about the same in both."[11]

Although Army leaders recognized the unsatisfactory nature of this system, they could not develop realistic solutions. Brigadier General Pope, Commander of the Department of the Missouri, repeatedly proposed closing some of the smaller forts in order to create larger, permanent installations. Yet his suggestions were ignored as politically unfeasible because settlers demanded Army units nearby where possibility of conflict existed. Army generals complained that settlers, in order to have a market for their products, also exaggerated the danger from Native Americans.[12]

By the early 1880s, however, the number of conflicts with Native Americans had decreased. As settlers gradually moved westward, they came to outnumber the Native Americans. Moreover, the slaughter of buffalo made the Plains tribes dependent on the U.S. government for subsistence.[13]

Under these circumstances, the Army articulated a policy for consolidating small garrisons into larger installations. In 1880, William T. Sherman, the Commanding General of the Army, recommended that the Army direct its attention towards improving its ability to fight conventional wars and improving discipline. In addition to the comparative quiet of the Native Americans, Sherman also noted that the development of railroads allowed troops to move to potential trouble spots more quickly than previously possible.[14]

In 1882, Sherman presented a plan to Congress that received the support of Secretary of War Robert Lincoln. He divided the forts of the western states into three categories: (1) those posts that should be retained permanently, (2) those posts that were needed for 10 to 15 years, and (3) those posts that should be abandoned. He advocated improving the first category with quarters of "brick or stone of the most permanent character, meant to last forever." Installations in the second category were to be improved with frame buildings of a semi-permanent character. The permanent installations generally were located near communications centers, where supplies were obtained readily and troops could be dispatched to trouble spots easily.[15]

Not surprisingly, most of Sherman's generals readily endorsed his proposal. During the 1880s, the War Department's *Annual Reports* to Congress repeatedly contained reports on the consolidation efforts. At Ft. Robinson, Nebraska, which was in the category of posts to be retained temporarily, the first contractor-built barracks were added in 1887, much to the soldiers' pleasure. Yet despite the acknowledged benefits of the consolidation program, the slow rate of construction at the permanent posts and lack of funding hindered progress. Some units remained on isolated posts with long-decayed "temporary" billets throughout the remainder of the century, waiting for permanent quarters to be built. Moreover, the consolidated garrisons were small by today's standards. In his 1894 report, the Secretary of War noted that garrison strengths ranged from 60 to 750 soldiers.[16]

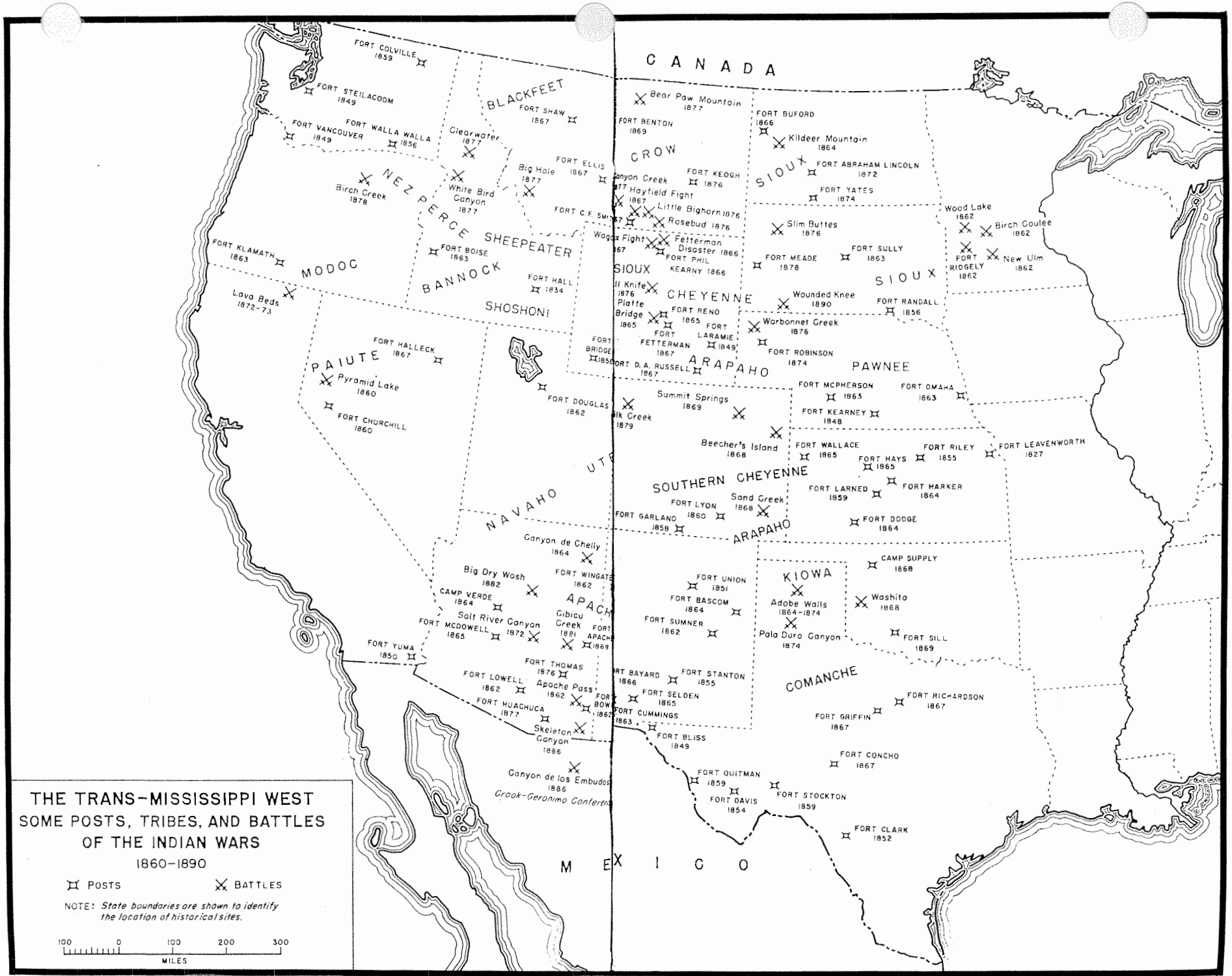

Figure I-3. Army posts and engagements during the Indian Wars. (From Matloff, *American Military History*, 1969)

As part of its efforts to improve the living conditions of its members, the Army also increased its use of standardized building plans, especially for officers' quarters. The Quartermaster Department, which had responsibility for military housing at that time, had developed standardized housing plans since the 1860s.[17] The temporary quarters that characterized so many of the frontier posts appear to have been built according to the desires and abilities of the soldiers. In 1882, General George Crook, Commander of the Division of the Missouri, complained about the lack of standardized housing, even at a single post. He noted that differences in the quality of quarters created problems because it was customary for senior officers to select the best quarters on post, regardless of whether or not they were occupied. Thus, a new arrival might "bump" a junior officer out of his quarters, who would in turn displace a more junior officer.

> The ... selection of quarters by officers are one of the greatest causes of annoyance and of discord in garrisons. This arises from the lack of system which has heretofore prevailed in the construction of our posts. If quarters were made uniform for the several grades in the permanent posts hereafter to be erected, there would seem to be no adequate reason why an officer should be disturbed after having once settled. Officers subsequently joining the garrison could, then, without injustice be required to select from unoccupied quarters.

In his 1881 report, Crook recommended that plans for quarters be "drawn by a competent architect, and that they be made, so far as is practicable, uniform in size in all posts throughout the country."[18]

Recreational opportunities at these posts were limited. Many forts contained a library, which seemed to have been widely used by officers and enlisted men. Baseball was another common diversion. The sutler's or post trader's store sold personal items, usually at a significant profit. Until President Rutherford B. Hayes prohibited the sale of whiskey in 1881, soldiers could drink at the sutler's; after that time, soldiers purchased their whiskey at notorious "hog ranches" located just beyond post boundaries.

In 1880, some officers at Vancouver Barracks, Oregon, conceived of an idea to improve the morale of the soldiers by opening a "canteen" where soldiers could eat, play games, and relax. The commander approved the plan. Four years later, while commanding Ft. Sidney, Nebraska, the same commander authorized another canteen, this time authorizing the sale of beer and using the profits as a post morale fund. The idea proved to be a success. Soldiers spent less time drinking hard liquor off post, with a corresponding decrease in disciplinary actions. The profits enabled the soldiers to improve the quality of their lives. Soon the canteens began to sell general merchandise and to displace the post traders. They acquired a new name, the "Post Exchange," which signified their expanded role as the beginning of the modern non-appropriated fund system.[19]

The modern retail commissary system also could trace its origins to the late nineteenth century. In 1866, Congress directed the Subsistence Department to sell grocery items to soldiers. In 1868, the Commissary General published a list of items beyond the basic ration that could be sold by the post commissary sergeant. The Subsistence, or Commissary, Department's primary responsibility remained the purchase of rations to issue to soldiers. Retail sales were an adjunct to these responsibilities. In time, the retail sales expanded and the Subsistence Department allowed military personnel to special-order selected items. The development of separate commissary stores later followed.[20]

At the end of the 1880s, the Army was poised to begin the consolidation and standardized construction that characterized the next era of War Department construction. The settlement of

the majority of the American West by settlers of European descent, the end of the Indian Wars and resettlement of Native Americans into reservations, and the expansion of railroads ended the era of scattered, temporary frontier posts.

Coastal Defense

America's coastal defense system also languished during the years following the Civil War. The Third System of masonry fortifications was more than adequate to protect America's harbors against any antebellum Navy. These forts were designed to withstand attacks from wooden sailing ships that fired smooth-bore cannon. As such, their masonry walls were strong enough to withstand ships' guns, and their own guns could endanger wooden ships.

Yet almost as soon as it was completed during the mid to late 1850s, the coastal defense system became obsolete. During the Civil War, the Union Navy discovered that its steamships and ironclad vessels could run past Third System forts with acceptable losses. After the war, naval technology advanced rapidly, especially in the European navies, while America's coastal defense system remained stagnant. Increased steel plating and improved steam propulsion made ships less vulnerable to the old smooth-bore guns of America's forts. More importantly, improvements in naval ordnance resulted in breach-loading, rifled guns that could demolish a fort's masonry walls.[21]

Even with such obvious deficiencies, the government made little effort to strengthen the seacoast defenses beyond completing the Third System and adding some underwater mines (torpedoes). Even as late as 1885, Admiral Porter complained to Congress that the forts that were intended to protect the Navy's shore facilities would instead require the Navy's protection: "In other days, when wooden ships and smooth-bore guns decided matters on the high seas, ships could seek the protection of forts; but hereafter forts will require the protection of iron-clads to keep off other ironclads."[22]

In response to these criticisms, President Grover Cleveland appointed a board of experts in 1885 to study the coastal defense system and make recommendations for its improvement. This became known as the "Endicott Board," named after its president, Secretary of War William Endicott. Upon the Board's recommendation, the Army installed batteries of heavy artillery along the coastline at strategic points. These batteries no longer had the appearance of classic harbor defense fortifications. Instead, they consisted of heavy guns placed behind parapets for shelter, and dispersed for greater protection.[23]

Soldiers serving in coastal fortifications lived in the casemates, despite chronic complaints about the unhealthy conditions. From the beginning of the coastal defense system, officers complained about the damp, cold living conditions of the casemates, without results. Again in 1875, the Inspector General of the Army "urgently recommended" special appropriations to construct barracks for coastal defense units. Casemates were "without exception, damp, illy ventilated, and unhealthy. This has given rise to continued well-grounded complaints, with numerous applications for more salubrious quarters, and these requests have been enforced by our medical officers."[24] Yet nine years later, in 1884, the Quartermaster General was still pleading with Congress for money to construct barracks: "It is not humane to make men live in these structures which are unhealthy, unsuitable, and injurious to the mental and physical character of the occupant."[25] Adequate living conditions for the coast artillery soldiers came with the general improvement of soldiers' living conditions during the late 1880s and 1890s.

Ordnance Department

The Ordnance Department continued to maintain its system of arsenals and armories. With the destruction of Harper's Ferry during the Civil War, however, Springfield became the Army's only armory. In 1862, Congress authorized the establishment of a three small storage and repair depots in the Midwest, including one at Rock Island, Illinois. In 1864, the Rock Island facility was designated an ordnance manufactory. Despite the intention to establish a great manufacturing arsenal at Rock Island, the arsenal produced little ordnance during the nineteenth century. Most of the work conducted in the shops supported the production of construction materials for the arsenal's buildings. In 1888, Congress authorized the first Army Gun Factory at Watervliet Arsenal for the manufacture of artillery, including large coastal defense cannons and field pieces. Watervliet's former production of artillery carriages was transferred to Rock Island Arsenal.

Though the Ordnance Department maintained a series of regional depots that served the western forts, it lacked sufficient storage capacity for explosives on the East Coast. In 1880, the Ordnance Department selected an isolated site near Dover, New Jersey (now Picatinny Arsenal) that was accessible to railroad transportation and close to the port of New York.

With the establishment of Sandy Hook Proving Ground in 1874, the Ordnance Department instituted another type of installation. Prior to that time, ordnance testing was performed at the limited facilities of the Ft. Monroe artillery range. The Sandy Hook facility had a longer firing range that could test fire the larger caliber coastal defense weapons of the Endicott period. It remained the Army's testing facility until it was replaced by Aberdeen Proving Ground during World War I.[26]

Quartermaster Depots

During the post-Civil War years, the Quartermaster Department consolidated and organized its depot system. The Army had used depots as regular supply bases on a limited scale since the Seminole War of 1835 - 1842. In 1859, the War Department designated the larger Commissary Department and Quartermaster Department facilities as general depots (until 1912, the Quartermaster Department and the Commissary Department were two separate agencies.) With the massive requirements of the Civil War, the number of depots and the level of activity increased accordingly. After the war, the Army reduced both its stocks and number of storage facilities. By 1869, the Quartermaster General controlled four general depots at New York, Philadelphia, Washington, and Jeffersonville, Indiana. Smaller depots existed within the geographic military departments and drew their supplies from the general depots.[27] For example, Ft. Leavenworth, Kansas, served as the main quartermaster depot for new frontier posts the Army was establishing along the Santa Fe, Oregon, and California Trails.

Signal Corps

Ft. Myer in Arlington, Virginia, acquired a distinctive mission. Originally named Ft. Whipple, the post was part of a network of fortifications defending Washington, D.C. during the Civil War. Interest in military communications had languished after the Civil War. Then in 1870, Congress assigned a new mission to the War Department, that of collecting weather observations and signaling storm warnings across the nation. The Signal Corps operated the forecasting service in the United States, and Ft. Whipple became the site of the first weather service. By instructing all observers to take weather measurements simultaneously, the Signal Corps produced the first weather forecasts in the United States.[28]

Education

Before the Civil War, most military training concentrated on entry training for the future officers at West Point, and for the enlisted men at the various recruit depots. The only program for educating soldiers after they had entered the service was the Artillery School of Practice at Ft. Monroe. During the 1880s, however, the Army instituted new programs that became the foundation for its imposing system of continuing military education. An increasing number of installations later derived their primary importance as training facilities.

In 1868, the Army revived its Artillery School at Ft. Monroe, which had been discontinued in 1860. Here, artillery officers received advanced instruction in branch-related skills. In the late 1860s, a group of officers from the Corps of Engineers instituted the Essayons Club at Willets Point, New York, now Ft. Totten, to perpetuate a knowledge of military engineering. These efforts grew into the Engineer School of Application in 1875. In 1869, the Army established a Signal School at Ft. Whipple, Virginia, now Ft. Myer; although the fort became a cavalry post in 1886, a signal school returned between 1898 and 1905. An act of Congress in 1887 authorized the Cavalry and Light Artillery School, although it was not established at Ft. Riley until 1892. At first, this school concentrated on training entire units, rather than individual soldiers.[29]

In time, the schools at Ft. Leavenworth achieved a preeminent position in the Army's education system. Instruction at Leavenworth began in 1881 when the Army authorized the School of Application. This school was designed to offer selected instruction in combined arms and higher levels of operations. Initially its students consisted of junior second lieutenants, who required instruction in basic small unit tactics. With the support of Army leadership and determined instructors, Leavenworth became a school for advanced military education. The schools at Leavenworth underwent several name changes and reorganizations until it became the Command and General Staff College, a name which lasted through World War II.[30]

Navy and Marine Corps

From the close of the Civil War to 1881, the Navy Department had deteriorated to the point where the secretary considered it to be "a subject of ridicule at home and abroad."[31] Beginning in the 1880s, however, it began the first steps towards transforming itself into a modern fighting force. These changes began with the incorporation of new naval technology into the American fleet. Yet the advent of new technology soon led to new concepts of naval strategy, as Navy leaders turned towards fighting major fleet actions. With the increasing sophistication came new requirements for training and education of both officers and enlisted men.

The Navy's shore establishment also reflected this trend towards a more modern Navy. Despite the political reluctance to spend money, the Navy began to repair the yard's physical deterioration that followed the post-war neglect. Equally importantly, the shore establishment began to expand into new training, research, and testing functions that were required to support a technologically advanced force.

Results of the Civil War

The Union Navy performed three important functions during the Civil War. It closed the Southern ports, either through blockades, or by attacks on the ports. Its gunboats opened the Western rivers for the Union forces. With less success, the federal Navy also tried to end the attacks on Northern commerce by Confederate raiders, such as the *Alabama*. Using any available vessels, the Navy expanded sufficiently to perform these missions. After the war, however, the

Navy rapidly disposed of its wartime ships and personnel. Soon it returned to its antebellum composition, even though European navies were modernizing rapidly.[32]

The Navy's shore establishment emerged from the Civil War with fewer facilities than it possessed in 1860. The Navy Department had assembled its temporary fleet of warships without acquiring any new yards. The valuable Norfolk and Pensacola Yards had been seriously damaged during the war. The Memphis Yard closed permanently. In an 1865 *Annual Report* Gideon Welles, the Secretary of the Navy, complained that:

> Our navy yards are, all of them, of limited area, and wholly insufficient for our present navy. Not one of them presents the full requisite conveniences and facilities for promptly fitting out ... more than a single vessel at a time. Vessels which ought to be repaired in three months are often detained for a year, and officers ordered to their ships which should be ready for sea have been kept waiting for months, at great expense to themselves and to the country and to the injury of the service.
>
> There is not a public yard where an iron vessel can be constructed, or where shafting can be forged, or steam machinery manufactured, except on a moderate scale.[33]

Yet during the immediate post-war years, Congress was unwilling to appropriate money for the Navy, given the war debt and the lack of a visible threat. In 1870, the secretary again complained that few improvements had been made on the Navy yards since the war; in fact, Congress had appropriated almost no money for yards in 1869 (Figure I-4).[34] Congress not only declined to spend more money for the Navy, but in 1875, the Senate directed its Naval Affairs Committee to study the feasibility of reducing the number of yards. Although the committee's study had little effect other than to hasten the transfer of the Philadelphia facility to another site, it indicated the general lack of interest in military affairs.[35]

The Navy did make some progress with its shore facilities. The Norfolk Yard was partially rebuilt; the Pensacola Yard also was repaired to a lesser extent. The Navy Department acquired a site in the Delaware River on League Island, a few miles south of Philadelphia, to replace the crowded Philadelphia Yard. On the whole, however, the yards were no better than the Navy's fleet of antiquated wooden ships.

Beginnings of Naval Modernization

The Navy could not remain stagnant forever. By the early 1880s, the deficiencies of the Navy had become too obvious to be ignored. The first signs of modernization came in 1883, when the department began construction of three new "protected" steel cruisers, the *Atlanta*, *Boston*, and *Chicago*. Each contained a thin steel hull, but heavier protection for its vital areas. The cruisers were designed to use sail power for normal cruising, but could rely on steam power during battles. These new ships were followed by larger battleships, such as the *Maine*, *Texas*, *New York*, and *Olympia*. These ships required smaller escort ships and auxiliary vessels, especially colliers. A modern Navy was beginning to form.[36]

Efforts to construct the first steel warships indicated the extent of the deterioration of the Navy during the post-war years, including the shore facilities. The Navy recognized that it could not build these ships and had to rely on contractors. However, the bureaus lacked the technical expertise in preparing drawings and specifications. Consequently, preparation of plans was not completed until after the contracts had been awarded. The contract went to a prominent

Republican, and when the administration changed to Democratic in 1885, Cleveland's new Secretary of the Navy, William Whitney, found the contractor to be in default and attempted to take control of the construction. He discovered, however, that no Navy yard was large enough to construct these ships, so the Navy Department completed construction of the ships in the contractor's yards, under the supervision of Navy engineers.[37]

Navy yard improvements came slowly during the 1880s. In his 1885 *Annual Report,* Secretary Whitney noted that:

> It appears from his [the Bureau of Yards and Docks] report that this property, aggregating in value some fifty millions of dollars, is falling rapidly into a condition of extreme decay. The reports from the yards make frequent complaint of buildings falling or about to fall; roofs leaking to such an extent as to involve the destruction of property stored underneath; wharves so rotten that persons cannot walk over them in safety; stone dry-docks which are required to be shored up with timber; bad roadways, defective water pipes, and in general such an extent of decay and dilapidation as to imply a general destruction.

Although the 1890 *Annual Report* still complained about the lack of appropriations for maintenance, the secretary also noted that two stone dry docks had been constructed in New York and Norfolk, with another under construction at Mare Island. All three of these installations also had received new wooden dry docks. Navy yards were slowly beginning to modernize.[38]

Once the process of modernization began, it acquired a momentum that continued until the U.S. Navy rivaled that of Britain. An effective Navy was essential to the nascent imperialism of the late nineteenth century, and the new Navy received bi-partisan support. Merchants perceived that the Navy would be beneficial to their overseas operations. Because European navies also were expanding, the U.S. Navy needed to keep pace with potential competitors.

Changing Roles of Shore Installations

For the Navy's shore establishment, modernization meant more than simply an improvement of facilities. It also resulted in different types of missions. Until the 1880s, Navy shore facilities served as ship yards, workshops, and depots of supply.[39] As such, they simply performed the industrial and supply functions required to support a Navy consisting of sailing ships. Yet the modern Navy required that officers and enlisted men be trained to perform more technical duties; therefore, the Navy developed an education system. Sophisticated weapons and equipment required careful research and development work, which also was performed on shore facilities. The new demands for coal and munitions prompted the creation of coaling stations and naval magazines.

These changes did not necessarily develop immediately, or with a clear sense of purpose. Often, specialized functions began tentatively and grew gradually into major functions of the shore establishment. In fact, the shore establishment continued to develop new missions through the end of World War I.

Ordnance testing began at the Washington Navy Yard on an *ad hoc*, almost casual, basis. Even before the Civil War, the yard's importance as a gun factory, and the presence of Lieutenant Dahlgren as ordnance officer, resulted in occasional tests of new guns. In 1862, the use of ironclad vessels resulted in the testing of metal plate by firing artillery into the plate at the Washington Yard.[40]

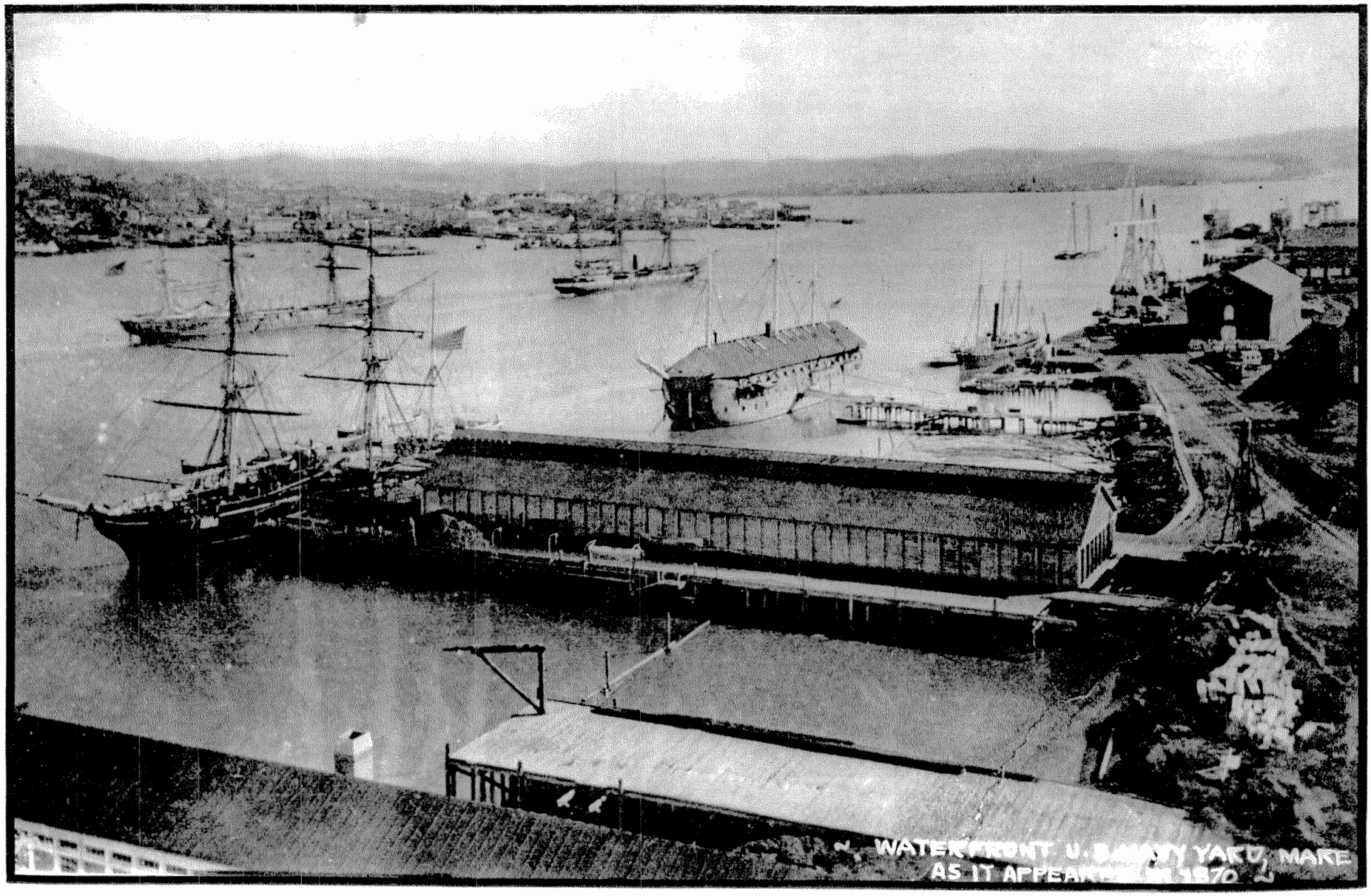

Figure I-4. Mare Island Navy Yard, 1870. After the Civil War, the U.S. Navy continued to rely on wooden sailing ships and deteriorating Navy yards received few improvements. The receiving ship, *center*, was a decrepit ship used as temporary housing for enlisted personnel. (Courtesy of the Naval Institute)

Between 1880 and 1885, however, the Navy concluded that it required a more systematic method of testing new guns, especially in view of the Army's success with the Sandy Hook Proving Ground. Consequently, the Navy established a proving ground at Annapolis, Maryland. The Annapolis Proving Ground's activities included "testing of guns, ascertaining the best composition and temper of steel for armor-piercing projectiles, and the resistance of steel and other armor plates, the measurement of chamber pressures in the different classes of guns; the employment of gun cotton in armor-piercing projectiles, and various other very important operations."[41]

Despite the Navy's pleasure with having a proving ground, Annapolis was an unsuitable site for firing heavy weapons, especially with the presence of a large hotel halfway down range. The department desired a more isolated location. In 1887, Congress authorized the purchase of an isolated tract of land in Charles County, Maryland, at Indian Head. The Navy purchased the site in 1889, and it proved to be eminently suitable for the Navy's needs. Its position on the Potomac River allowed the Navy to transport heavy guns from the Washington Yard to the Indian Head site for testing. The Indian Head site was used to test-fire new weapons, and to continue experimenting with new types of ordnance.[42]

Another innovation in naval ordnance, the use of underwater mines (called torpedoes), resulted in the creation of the Torpedo Station at Newport, Rhode Island. The station began with the acquisition of an Army coast artillery fort (Ft. Woolcott) by the Navy in 1869, and the assignment of three officers to the station. Initially, the station concentrated on experiments with stationary torpedoes, but soon expanded its interest to the new "automobile torpedo."[43]

The invention of the torpedo also prompted the Navy to experiment with a new type of vessel, the torpedo boat, using the Torpedo Station and Naragansett Bay. The first of these boats, built in 1886 and 1887, were only 139 feet long and displaced only 105 tons, with a crew of two officers and 20 men and an armament of three above-water torpedo tubes. They were intended primarily for a coastal defense role, with an expected capability to maneuver quickly against a larger ship and fire their torpedoes.[44]

In practice, the torpedo boats did not fulfill their expectations. Yet in other ways, they were important to the development of the Navy; they were the precursors of the modern destroyers. Moreover, the experiments with torpedo boats at the Torpedo Station marked further growth in the complexity of the shore establishment, for now the Navy had begun experimentation with new types of vessels using its shore facilities.

Because of the new technology required for torpedo warfare, the Navy initiated a course of instruction at the Torpedo Station, designed for officers in the middle of their careers. Like other innovations of this time period, the Torpedo School began as a modest venture that eventually became part of a larger pattern of changes in Navy practices. Navy officers had received no formal education after commissioning; they were expected to improve their skills as they progressed in their careers. By 1880, the Torpedo School was in full operation, with a full course of instruction. The program included lectures and practical exercises in electricity, fuses, diving, and torpedoes.[45]

The institution of the Torpedo School soon was followed by the creation of the Naval War College, also at Newport, Rhode Island, in 1884. This time, the innovation was recognized as a clear departure from the previous practices in that it was a school for teaching officers the theoretical aspects of naval warfare. Despite the opposition of many traditional admirals, the school established a reputation for excellence, and became one of the Navy's most prized institutions.[46]

Systematic training of enlisted men also began at Newport with the creation of the Naval Training Station in 1883. The training station originally consisted of both shore facilities and a "Training Squadron" of ships. The apprentices were billeted aboard ships, but received part of their training on land. Crowded conditions on the ships, however, eventually required the Navy to construct barracks on shore.[47] Training on land was followed with a cruise on one of the Training Squadron's sailing ships, in a system that continued throughout the nineteenth century.[48]

Beginning in the 1880s, the Washington Navy Yard began offering career enlisted men advanced training in ordnance and electricity, with schools at the Washington Navy Yard and the Torpedo Station. By 1890, average enrollment per year was only 25 for the Washington Yard and 27 for the Torpedo School. Yet these courses marked a concept of offering technical education to enlisted personnel beyond the initial training.[49]

Throughout this period, the Navy remained hindered by its system of independent bureaus. Each bureau reported independently to the Secretary of the Navy, with no systematic method of orchestrating their activities. The Bureau of Construction and Repair managed the hull and essential features of the ship, while Steam Engineering was responsible for the power plant, and the Bureau of Ordnance designed the weapons. Any ship design required the concurrence of all three bureaus. Yet another bureau, Equipment and Recruiting, provided anchors, sails, cordage, and other equipment. The Bureau of Provisions and Clothing provided clothing and subsistence. The Bureau of Medicine and Surgery managed the medical care of the Navy. The Bureau of Navigation originally was intended to produce charts and navigation aids, but eventually dominated the other bureaus by its ability to control ship movements and officer assignments.

In theory, the Bureau of Yards and Docks had supremacy over the Navy's shore installations, yet in practice the bureau system divided authority within the yards. The Bureau of Yards and Docks assigned the yard commandant, but each of the other bureaus had responsibility and authority for their activities within the yard. Although the Bureau of Yards and Docks controlled most shore installations, some special function installations were controlled by other bureaus. For example, the Bureau of Ordnance had responsibility for the Proving Ground and for the Torpedo Station. The Bureau of Navigation was responsible for the Naval Academy, the Training Station, and the War College.[50]

Marine Corps

For the Marine Corps, this time was a period that one of its historians termed "its doldrums."[51] Marines distinguished themselves during the Civil War as members of landing parties, and served as gun crews. Yet after the war, they continued to perform the same missions as before the war, that of providing Marine complements on warships and guards for Navy yards. While at sea, they maintained order on ship and served on landing parties (Figure I-5). Guard forces for Navy yards were housed at Marine Corps barracks that either were located on or directly adjacent to the yards. The Marine Corps had not yet reached the point where it would operate in large formations independently of the Navy.

Figure I-5. The Marine complement on ships formed the principal mission of the Marine Corps during the nineteenth century. The Marines of the USS *Alliance* manned a 3-inch rifled gun. (Courtesy of the Naval Institute) 39

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36. Hagan, *This People's Navy*, 186-187.

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38. Secretary of the Navy, *Annual Reports* (1885), iv; (1890), 56.

39. Secretary of the Navy, *Annual Report* (1885), iv.

40. Henry Hibbens, *Navy-Yard Washington: History from the Organization 1799 to the Present Date*, Senate Executive Document No. 22, 51st Congress, 1st Session pp. 67, 88-89, 114.

41. Secretary of the Navy, *Annual Report* (1885), vi-vii, 209-210.

42. Secretary of the Navy, *Annual Reports* (1885), 209-210; (1890), 252-253. A 1914 map of Charles County shows a railroad network connected to a dock, but not to the rest of the county, thus suggesting that heavy guns were transported by water. *Map of Charles County. Showing the topography and election districts.* (Maryland Geological Survey, 1914).

43. Paolo E. Coletta, *Navy and Marine Corps Bases, Domestic* (Westport, Connecticut: Greenwood Press, 1985), 213-221; Secretary of the Navy, *Annual Reports*, passim.

44. Alden, *The American Steel Navy*, 103-104.

45. Secretary of the Navy, *Annual Reports* (1875), 89; (1880), 90.

46. Hagan, *This People's Navy*, 188-190; Ronald Spector, *Professors of War: The Naval War College and the Development of the Naval Profession* (Newport, Rhode Island: Naval War College Press, 1977), *passim*.

47. Coletta, *Navy and Marine Corps Bases, Domestic*, 117-119.

48. Alden, *The American Steel Navy*, 171-172.

49. Secretary of the Navy, *Annual Reports* (1885), 206-207; (1890), 256.

50. Alden, *The American Steel Navy*, 237-239.

51. Alan R. Millet, *Semper Fidelis: The History of the United States Marine Corps* (New York: Macmillan Publishing Co., 1980), 100-114.

CHAPTER 3
THE MILITARY AND THE PROGRESSIVE ERA, 1890 - 1918

The beginning years of the twentieth century have been termed the "Progressive Era" because of a prevailing commitment to reform of American institutions. This trend affected the military services. Modernizing initiatives begun during the 1880s were continued at an accelerated pace. The services readily adopted new technology, the most important of which was the airplane. During these years, the Marine Corps began to operate in larger units, not merely as ships complements for the Navy.

The Progressive Era was punctuated by two wars that affected the modernization of the military. The Spanish-American War demonstrated that previous reforms had been invaluable, but insufficient. It also marked the beginning of military involvement overseas. World War I brought the United States to the status of a world power.

Army

Army changes during these 28 years were profound. At the beginning of the period, the Army consisted of widely scattered units distributed throughout the western states. By the close of the period, the United States fielded an army capable of fighting the best trained and equipped European armies. Its officers demonstrated an increased commitment to military professionalism, most demonstrably through an improved educational system. The creation of a General Staff in 1903 greatly improved the command structure. Some of its most noteworthy leaders were prominent reformers, such as Secretary of War Elihu Root, or Chiefs of Staff Leonard Wood and J. Franklin Bell.

Army Operations

Increased American involvement in international affairs created new missions for the Army. For the first time since the Mexican War, the U.S. Army operated outside the continental United States on a sustained basis. In 1898, the United States entered a war with Spain over Cuban independence. Army forces moved to Cuba, where the bulk of the ground fighting occurred. Another Army expedition captured the Spanish-owned island of Puerto Rico. Other soldiers remained in Cuba on occupation duty until 1902 to establish a provisional government.

Spain also had relinquished the Philippine Islands to the United States. Filipino nationalists wanted independence for their islands, and the Army entered a guerrilla war termed the Philippine Insurrection by the Americans. The hostilities officially ended in 1902 even though many Filipinos continued the fighting for several years. The United States retained the islands as a colony until after World War II. The War Department administered the islands, and the Army continued to station troops in the islands.[1]

After the United States acquired the right to build a canal across the Isthmus of Panama, officers from the Corps of Engineers supervised construction of the canal from 1907 to 1914. The success of the Army Medical Department in controlling yellow fever during the construction of the canal was a notable achievement. After completion of the canal, the Army stationed units in Panama to protect the waterway.[2]

The Mexican Revolution of 1911 produced a further challenge for the United States Army. As the revolution progressed, relations between the United States and Mexico deteriorated.

Following an incident with American sailors in Tampico, war appeared to be a real possibility. Relations temporarily were calmed until the Mexican revolutionary Pancho Villa crossed the United States border and attacked U.S. citizens. In response, President Woodrow Wilson ordered Brigadier General John J. Pershing and thousands of troops from Ft. Bliss, Texas, into Mexico in a futile pursuit of Villa. The Americans eventually withdrew from Mexico in January 1917 in the face of the impending entry into World War I and failure to accomplish their objective. From this time until the beginning of World War II, the Army continued to patrol the Mexican border.[3]

The biggest military operation of the period was the American entry into World War I. For the first time since the Civil War, the United States mobilized its resources, including a conscription program and government management of war-related industries. The Americans turned the tide into an Allied victory by contributing more than four million soldiers when the European armies were exhausted.

Closing the Frontier and Consolidating Posts

In his 1890 report, the head of the Census Bureau announced that a discernable line constituting a frontier no longer existed. In that year, the Army also fought its last important battle with Native Americans at Wounded Knee. For the Army, these events marked the end of its mission to protect settlers and subdue Native Americans and settlers. Although settlers still feared occasional threats of hostilities from Native Americans, the Army's 100 years of duty as a frontier constabulary ended. It then focused its attention on functioning as a conventional military force.

For the Army, the closing of the frontier allowed it to accelerate efforts to consolidate its posts into larger garrisons. The advantages of the consolidation policy were expressed by the Secretary of War in his 1891 *Annual Report:*

> Twenty-eight army posts, about one-fourth of the entire number June 1, 1889, have been abandoned since that date. Ten or twelve more can be abandoned as soon as suitable shelter for the troops is provided at more central points. The troops should be assembled by regiments, or least battalions, in well-built posts at strategic and convenient points as rapidly as it can be done consistently with adequate protection against possible Indian depredations. Even for this purpose it has been found by experience that troops stationed at convenient railroad centers are more available than those at posts nearer the scene of trouble but not on the railway. Besides the economy of transportation, supplies, etc., a much greater percentage of men is available for service from a large post than a small one. Fewer are employed outside of their legitimate military duty, and the discipline and drill of the command is improved.[4]

The consolidation movement continued under successive Secretaries of War. In 1894, a different Secretary of War noted another advantage of the consolidation process; soldiers finally received suitable quarters in the improved posts. Moreover, "concentration gives officers the opportunity to become familiar with the maneuvers of larger bodies in battalion and regimental formation. Improvement in the morale, discipline, and education of the Army has been no inconsiderable benefit."[5] The increase in size of Army posts was relative to their earlier size. In his 1894 report, the Secretary of War noted that garrison strengths ranged from 60 to 750 soldiers. Although 750 was a large garrison by the 1890s standards, such a post would be incredibly small by today's standards.[6]

The limitations caused by the small size of Army posts became apparent in 1911 when the Chief of Staff attempted to concentrate a large body of soldiers at San Antonio to practice

large-echelon tactics. It required 90 days to assemble 13,000 men into this so-called "Maneuver Division," and the division still lacked essential units. This situation was partially alleviated by creating "paper divisions," that is, by writing contingency plans in which the necessary regiments and other units were assigned to a division in advance of the emergency. In an emergency, units already knew their assigned divisions. The consolidation process was a significant improvement, but the Army still lacked experience in operating at echelons above a regiment.[7]

As part of the consolidation process, the War Department adopted a policy of constructing permanent quarters with adequate water and utilities. In 1893, the Secretary of War commented on the improved nature of Army posts. "In all posts which give promise of permanency it has been the aim of the Department to construct buildings of brick, stone, or other enduring material, and of solid workmanship, with regard to convenience and improved sanitary requirements."[8] Throughout the 1890s, estimates from the Quartermaster Department show an increasing number of quarters constructed of masonry. The Quartermaster Department produced hundreds of standardized plans as part of a national program during this period for a wide variety of buildings, including officer and NCO quarters, barracks, stables, telegraph offices, administration buildings, and riding halls (Figure I-6). While the Annual Reports of the Secretary of War during the post Civil War decades document continuous reports of poor conditions and lack of funds, the Annual Reports in the first years of the twentieth century focus on ways to manage the increased amount and costs of new construction.[9]

Coastal Defense

Coastal fortifications also benefitted from the resurgence of interest in military affairs. Recommendations of the Endicott board were implemented with increasing frequency, especially as the prospect of war with Spain became likely during the 1890s. The Endicott board had recommended using large guns, up to 14", in batteries placed outside old forts. In 1905, another board, called the Taft board, recommended further improvements in the coastal defense system, which were implemented gradually. Most of these improvements consisted of new sighting and communications equipment, not an increase in the caliber of guns.

Development of Professional Education and Training

One of the principal characteristics of the military in the Progressive Era was a commitment towards professional education. The Army increasingly developed schools to teach officers and enlisted men the specialized requirements of their profession. The schools at Leavenworth, which originated during the 1880s, expanded and became the Army's school for preparing field grade officers to command larger formations. In keeping with Ft. Leavenworth's new role as the home of military schools, the Signal Corps, the Corps of Engineers, and the Medical Department also opened specialized schools there.[10]

At the same time, other Army branches and departments opened specialized schools. Like many other developments of this period, specialized education began slowly. The Ordnance Department, in 1903, began teaching new ordnance officers their duties at the Sandy Hook Proving Ground, which marked the beginning of the Ordnance School. Following the separation of the Field Artillery from the Coastal Artillery, the Army opened a Field Artillery School at Ft. Sill in 1911.[11]

In 1901, Secretary of War Elihu Root achieved another one of his innovations, the creation of an Army War College. The War College, located at Washington Barracks (later renamed Ft. McNair), had two functions: (1) to allow senior officers to study the art of war at the national level,

and (2) to analyze strategic problems for the benefit of the Army. It worked closely with the Army's General Staff in developing strategic plans.[12]

Development of Logistical Functions

Another aspect of Army installation history, the development of logistical facilities, was characterized by a continuation of trends initiated during the 1880s. The Ordnance Department maintained its system of an armory, a proving ground, and multiple arsenals. The Quartermaster Department, converted to the Quartermaster Corps in 1912, expanded its system of depots.

Springfield Armory remained the Army's primary manufacturer and developer of small arms. Perhaps its best known production, the Springfield '03 rifle, a bolt-action repeating weapon, was developed in response to a need for a weapon that could compete with European firearms. This rifle remained in service until the eve of World War II.

For most of this period, Sandy Hook remained the Army's principal testing and experimental station. However, its small size limited both the quantity of work that could be performed there and the type of artillery that could be fired. In 1917, the Army established a larger proving ground at Aberdeen, Maryland, which replaced Sandy Hook. The Army also used a proving ground at Savannah, Illinois, as an adjunct to the Rock Island Arsenal.[13]

The Army's arsenals continued to perform their manufacturing and storage missions. They also added the mission of maintaining schools for enlisted personnel. In 1918, the Rock Island, Frankford, Augusta, San Antonio, and Raritan arsenals all maintained some form of enlisted training programs. Most schools were general schools for ordnance personnel, but others were specialized programs, such as Frankford's school for optical instrument repair. Manufacturing and storage functions also could be either specialized or general. For example, the Frankford Arsenal made optical instruments, while Edgewood specialized in chemical munitions, and Picatinny produced powder and high explosives. The New York Arsenal had no manufacturing facilities, but operated as a purchasing, storage, and shipping facility.[14]

The Quartermaster Department underwent some important changes, following the appearance of major logistical problems during the Spanish-American War. The most important of these was the merger of the Quartermaster, Commissary, and Pay departments to create the Quartermaster Corps. Other reforms also were attempted, including the reorganization of the quartermaster depot system in 1907. Under the new concept, the quartermasters of the various departments were allocated a budget that could be spent by drawing supplies from the Quartermaster Department's general depots. These general depots were the wholesale purchasers and managers of selected equipment. The system of general depots was expanded until the Quartermaster Corps controlled 13 depots in World War I.[15]

This number was woefully insufficient for the requirements of World War I, and the Quartermaster Corps relied heavily on commercial warehouses and held railroad cars to supplement their meager storage facilities. This situation led to the creation of a Warehousing Division within the Office of the Quartermaster General, with the responsibility for managing Quartermaster Depots.[16]

Figure I-6. 1897 Quartermaster Department standardized plan for double set of brick officers' quarters. Known locations: Ft. Omaha, Nebraska; Ft. Leavenworth, Kansas; Jefferson Barracks, Missouri; Ft. Porter, New York; Ft. Brady, Michigan; and, Ft. Ethan Allen, Vermont. (From Grashof, *Standardized Plans 1866 - 1940*, Vol. 3, 1986; original drawing source: National Archives, Cartographic and Architectural Branch, RG 77, P.I. NM-19, E. 411-#115)

Wartime Cantonments

One last aspect of the history of Army installations during this period was the creation of temporary cantonments during both the Spanish-American War and World War I. Many World War I camps evolved into permanent garrisons, although they had been created to meet the needs of the emergency.

With a sudden increase in volunteers for the Spanish-American War in 1898, the Army required a means of sheltering the recruits during training and then holding them until they could be transported to Cuba. Consequently, the War Department established a series of encampments across the United States. Of these 29 temporary camps, the debarkation point at Tampa, Florida, and the holding point at Chickamauga Park, Georgia, were the best known. After the war, all of these camps were disbanded; except for Anniston, Alabama, none of the sites were used again for military installations. They did provide experience in sheltering troops that was applied during World War I.[17]

Of these encampments, the experience of Camp Russell Alger perhaps was typical. The camp was established near Falls Church, Virginia, near Washington, D.C., to receive and train the newly-created II Corps. The site was selected on May 8, 1898. By May 13, the first volunteer units arrived to pitch their tents. By June, the camp was approaching its peak strength of about 23,000 soldiers. At first, the camp operated smoothly, despite comparatively primitive living conditions. Yet, in its haste to establish a camp, the Army had neglected to construct proper water and sewage facilities. The omission, when combined with the crowded living conditions, resulted in a typhoid fever epidemic that struck the camp in mid-July. By August, II Corps relocated to Pennsylvania in a futile effort to escape the typhoid epidemic, and Camp Russell Alger was abandoned.[18]

Throughout the Army, the temporary camps experienced similar problems with disease and sanitation. A total of 13,770 soldiers developed typhoid fever, with 907 deaths. After the war, two commissions were appointed to study the medical disasters of this war. One board, known as the Dodge Commission, examined the organization of the Medical Department. The other, called the Reed-Vaughan-Shakespeare Board, consisted of doctors directed to study the epidemiology of typhoid fever. The latter board noted that 90 per cent of the volunteer regiments developed typhoid fever within eight weeks after going into camp.[19]

In April 1917, the United States entered World War I, which had been devastating Europe since August 1914. For the Army, this war posed new problems that fully challenged its capabilities. The war introduced large scale use of poison gas and indirect artillery, as well as the use of new weapons such as machine guns, airplanes, and tanks. As the Army expanded to 62 divisions, 43 of which were sent overseas, Army leaders needed to learn how to command such large formations. War and Navy Department officials developed programs for coordinating America's industrial resources. Finally, the Army needed to induct and train more than two million soldiers as rapidly as possible.

Under these circumstances, cantonment construction became a critical factor in the war effort. The Army's expansion depended on an ability to shelter soldiers while they were trained and organized. With the unfortunate experiences of the Spanish-American War still in memory, senior officers wanted to ensure that the new cantonments contained adequate sanitary facilities and shelters. The War Department planned to construct 32 training camps by September 1, each capable of sheltering 40,000 soldiers. Responsibility for these camps was removed from the Quartermaster General and placed in a special "Cantonment Division," later called the "Construction Division," that reported directly to the Secretary of War.[20]

These camps were divided into two categories: (1) camps for the National Guard units that had been mobilized, and, (2) camps for the National Army, soldiers conscripted into the Army. Because the National Guard units were expected to be trained more quickly, the War Department decided to shelter the soldiers in tents, and to construct only the minimum number of wooden buildings. Of course, even these modest requirements involved considerable construction effort, as the War Department built roads, storehouses, and administrative buildings. The Army also constructed water and sewage connections to avoid the sanitation problems of the Spanish-American War. The National Army cantonments were constructed as temporary wooden shelters. Because the National Guard camps used canvas shelters, they were concentrated in the southern states, while the National Army camps were distributed across the nation.[21]

The scale of the effort for these camps was enormous, especially considering that the Army long had been accustomed to small posts. A typical camp, Camp Grant at Rockford, Illinois, cost about $11,000,000.00 to house 45,000 men and 12,000 horses. It contained 38 miles of water main and 1,450 miles of copper wire. During the construction period, 50 rail cars of material were unloaded every day. The camp contained 50,000,000 feet of lumber and 700 tons of nails. All the cantonments contained laundries, bakeries, kitchens, hospitals, cold storage facilities, theaters, and other buildings normally associated with a large city.[22]

At Camp Lee, Virginia, the contractor built 1,750 buildings, using 50 building types. The water and electrical systems were drawn from the nearby city of Petersburg. To meet the ambitious schedule, the contractor built fires to defrost the ground and to heat the sand and gravel mixtures. The tight time schedules required some compromises on sanitation requirements. The water pipes were constructed using wood staves, and leaked despite the best efforts of the builders. Sewage was poured directly into Bailey Creek, a tributary of the Appomattox River. A construction report noted that "There are no dwellings along Bailey Creek, and so far no nuisance has been caused by disposing of camp sewage in the creek."[23]

A remarkable number of the World War I training camps later became permanent Army installations. Ft. Devens, Massachusetts; Ft. Dix, New Jersey; Ft. Gordon, Georgia; Ft. Jackson, South Carolina; Ft. Lee, Virginia; Ft. Lewis, Washington; and Ft. Meade, Maryland, all had their origins as National Army Camps. Ft. McClellan, Alabama, and Camp Shelby, Mississippi, began as National Guard camps. In all, 9 of 32 mobilization cantonments survived to become permanent installations, many of which are now major Army posts.

In addition to the camps for line units, the War Department also constructed facilities to train soldiers in the technical branches. The Signal Department concluded that it required a training site near the major electronics manufacturers, and with sufficient real estate for students to practice communicating over a distance. Consequently, it established Camp Alfred Vail near Monmouth, New Jersey, which was later renamed Ft. Monmouth. Because of the amount of suitable land near Fayetteville, North Carolina, the Army created Camp Bragg as a field artillery range, and it created another field artillery camp at Camp Knox, Kentucky. Recognizing a greater need for training of infantry soldiers, the Army expanded the School of Musketry into the Infantry School, and placed it at Camp Benning, near Columbus, Georgia. The Quartermaster Corps trained its soldiers at Camp Joseph F. Johnston, near Jacksonville, Florida, and at Camp Montgomery Meigs, in Washington, D.C. Camp Humphreys (later Ft. Belvoir), located south of Alexandria, Virginia, became an engineer school, while Camp Eustis, at Williamsburg, Virginia, became a coastal artillery school.[24]

However, these training camps did not mark the end of the construction problems of the war. The Army also required a multitude of support installations, including quartermaster, ordnance, and medical facilities. The quartermaster constructed a series of depots near the Atlantic ports, and interior depots, such as the ones at Chicago and New Cumberland,

Pennsylvania. The largest construction project for the Ordnance Department was the construction of Aberdeen Proving Ground, with a sub-post at Edgewood Arsenal for preparing chemical munitions. The Ordnance Department also constructed new arsenals across the nation, including Raritan Arsenal, New Jersey, for holding munitions prior to shipment. The Army needed expanded medical facilities to care for war-related casualties and designated specific installations as general hospitals. Many soldiers returning from the front suffered from tuberculosis and other respiratory diseases resulting from living in trenches and bunkers. Returning soldiers also suffered from neuropsychiatric illnesses and were treated at hospitals designated for the treatment of "shell shock" patients. Most of the 294 hospitals were temporary facilities, with single-story wings connected by corridors. An exception to the temporary wartime general hospitals was Fitzsimons General Hospital at Denver, Colorado, which the Army built specifically to care for tuberculosis patients and maintained after most soldiers were demobilized.[25]

Beginnings of Army Aviation

Except for some Signal Corps balloons, Army aviation did not exist before 1908, but within 10 years, it developed into an important part of the Army. Even though aviation remained under the Signal Corps during these years, it began to function as a distinct entity. By the close of this period, many installations were separate aviation fields. This growth is all the more remarkable because most of it occurred between 1914 and 1918.

Army experience with heavier-than-air craft began with a test flight of a Wright brothers' airplane at Ft. Myer on 9 September 1908. The test flight was a success, but less than a week later, Lieutenant Thomas Selfridge became the victim of the military's first fatal aircraft accident. Despite this setback, the Signal Corps still desired airplanes for reconnaissance and courier duties. Consequently, the Army granted a contract to the Wright brothers to sell aircraft and to instruct Army pilots.[26]

The Wright brothers fulfilled the training part of their contract by opening a flight school at College Park, Maryland, just outside of Washington D.C. The Army assigned Lieutenants Frank P. Lahm, Benjamin D. Foulois, and Frederic E. Humphreys to College Park for training. Soon, Lahm received another cavalry assignment, and Humphreys resigned from the Army, leaving Foulois with only rudimentary flying instructions. In December 1909, Foulois and his airplane were transferred to Ft. Sam Houston, Texas before he had completed his training. He completed his training at Ft. Sam Houston by reading instructions from the Wright brothers.[27]

Progress for aviation remained slow. In 1910 and at the beginning of 1911, the Army's air arm consisted of Foulois and his one airplane (Figure I-7). In 1910, the Secretary of War requested funds for 20 airplanes, but Congress declined to fund the experimental device. One congressman is alleged to have asked "why all the fuss about planes for the Army -- I thought we already had one."[28] Even funding for this airplane was hard to find. When the Army wanted to move its airplane to the Mexican border in 1911, lack of money for maintenance made the aircraft unusable. The Army then accepted an offer from magazine publisher Robert Collier to borrow an airplane from him, which Foulois flew on reconnaissance and courier missions.[29]

In 1911, Congress appropriated $125,000.00 for Army aviation. The Signal Corps then purchased seven airplanes, and established a semi-permanent flying school at College Park, Maryland. Here, new pilots learned to fly, and other pilots experimented with new uses for the airplane. Aviators made the first experiments with aerial photography and bombing in 1911. The bombing consisted of dropping two 18-pound bombs from 400 feet. In 1912, Army aviators participated in ground maneuvers for the first time, and concluded that their reconnaissance capability gave a decided advantage to the side with aviation.[30]

Progress continued through 1913. The school was transferred to San Diego in 1913, at what is now a naval air station. Later that year, Congress authorized an Aviation Section of the Signal Corps with 60 officers, although actual strength rarely exceeded 30 officers. Also in 1913, the Signal Corps developed plans for the creation of an Aero Squadron at Ft. Sam Houston, although these plans were not funded until 1915.[31]

World War I Army Aviation

Military aviation achieved its own importance with the beginning of World War I. European generals rapidly discovered the value of aerial reconnaissance, using both airplanes and balloons. Energetic pilots soon decided to prevent enemy reconnaissance by engaging in aerial combat, and fighter aircraft appeared. Bombing began with small hand-held bombs that could do little more than harass the enemy. By the end of the war, specially designed bombers could reach behind enemy lines to damage rear areas.

In the United States, the Army responded to events in Europe with an increased interest in military aviation. In 1915, the 1st Aero Squadron began operations at Ft. Sam Houston, and soon afterwards joined General Pershing in his pursuit of Pancho Villa through Mexico. In the same year, the Army organized aero companies in the Philippines, Hawaii, and Panama. In 1916, the Army selected a number of sites to serve as flying fields, and when construction commenced at these fields the following year, they marked the beginning of the Army's separate aviation installations. Among the projects initiated during these years were Langley Field, near Hampton Roads, Virginia; Camp Kelly, near Ft. Sam Houston; Mitchell Field, Long Island, New York; and fields in Hawaii and the Philippines.[32]

These efforts proved to be inadequate, however, with America's entry into World War I, even a modestly respectable air component required a massive effort. The United States could purchase aircraft from Britain or France, but it required ground facilities to train new pilots. As a temporary expedient, the Army contracted for facilities at civilian schools. Congress also authorized the President to take possession of the North Island of San Diego, where the Signal Corps Aviation School already existed. Initially, the Signal Corps hastily acquired sites as they seemed available. As the war progressed, the Signal Corps established a site selection board to oversee the construction of future fields. In all, the Army acquired 33 tracts as flying fields, plus five other tracts at installations where flying was not the primary activity. A number of these survived the war to become permanent Air Corps fields, including Mather, Brooks, Kelly, Scott, Chanute, Selfridge, Wilbur Wright, Pope, Bolling, and Mitchell fields (Figure I-8).

At the same time, the Signal Corps also acquired a number of ancillary installations to support its aviation efforts. By the end of the war, it had acquired five aviation supply depots, three general aviation depots, and four acceptance parks for receiving aircraft from the manufacturers. Maxwell Air Force Base began as an engine and repair depot. It also established numerous schools for enlisted personnel, especially for mechanics, radio operators, and photographers. St. Paul, Minnesota, became the site for its mechanics school after the Army had contracted with the Dunwoody Institute to train 300 mechanics. When the number of trainees rapidly exceeded 300, the Army took over the Dunwoody Institute and leased nearby buildings to conduct its school.[33]

Like other World War I Army installations, the aviation fields were constructed hastily, and many were only half-finished by the end of the war. Only Langley and North Island fields had permanent buildings; other installations consisted of temporary wooden structures that were marginally sufficient to meet the needs of the emergency. Except for McCook Field in Ohio, all landing fields were gravel or cinder. Although many of these fields were abandoned or placed into

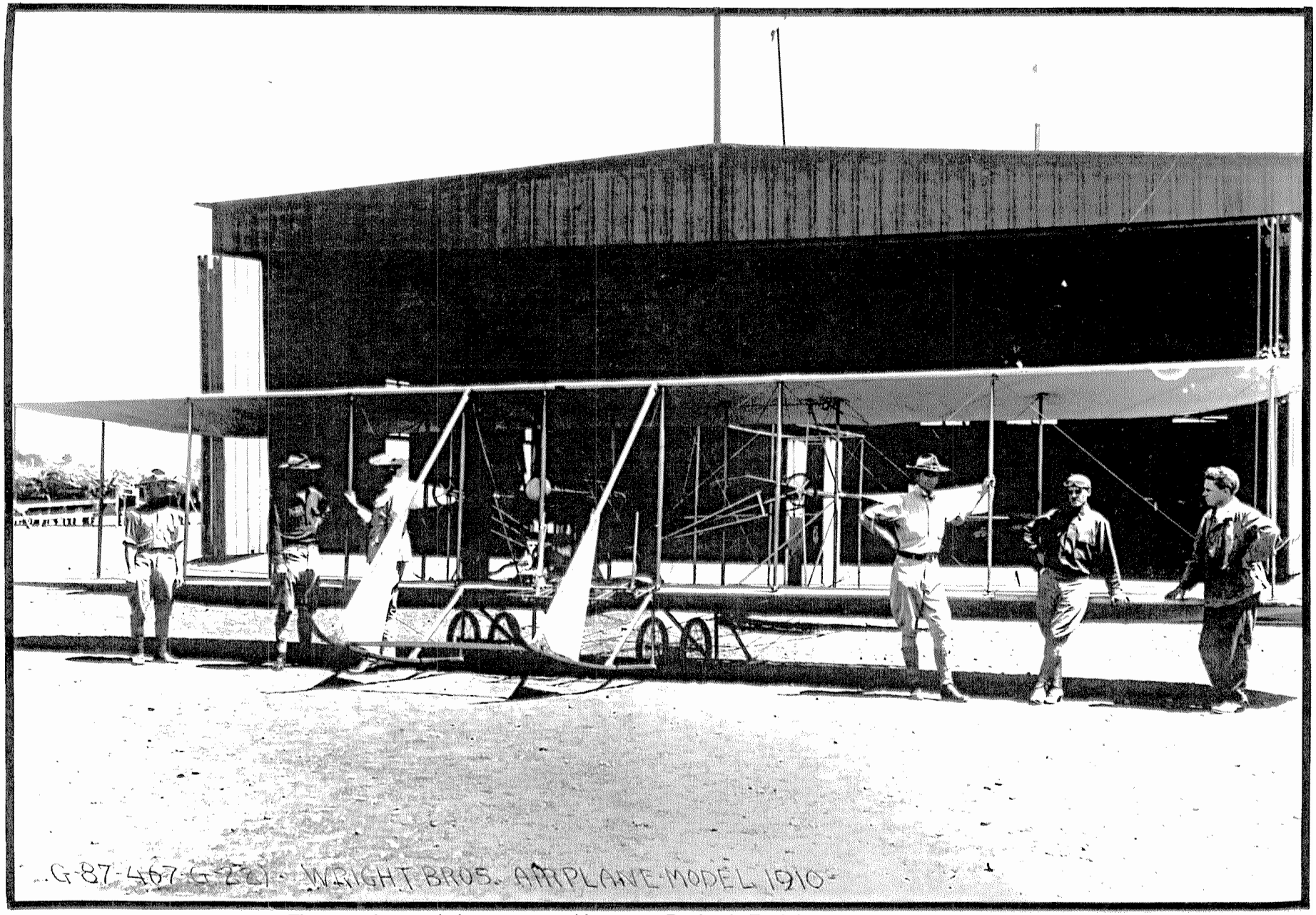

Figure I-7. The 1910 Army aviation program: Lieutenant Benjamin Foulois, *second from right*, and one Wright B flyer at Ft. Sam Houston. (Courtesy of the San Antonio Air Logistics Center Historical Office, Kelly AFB)

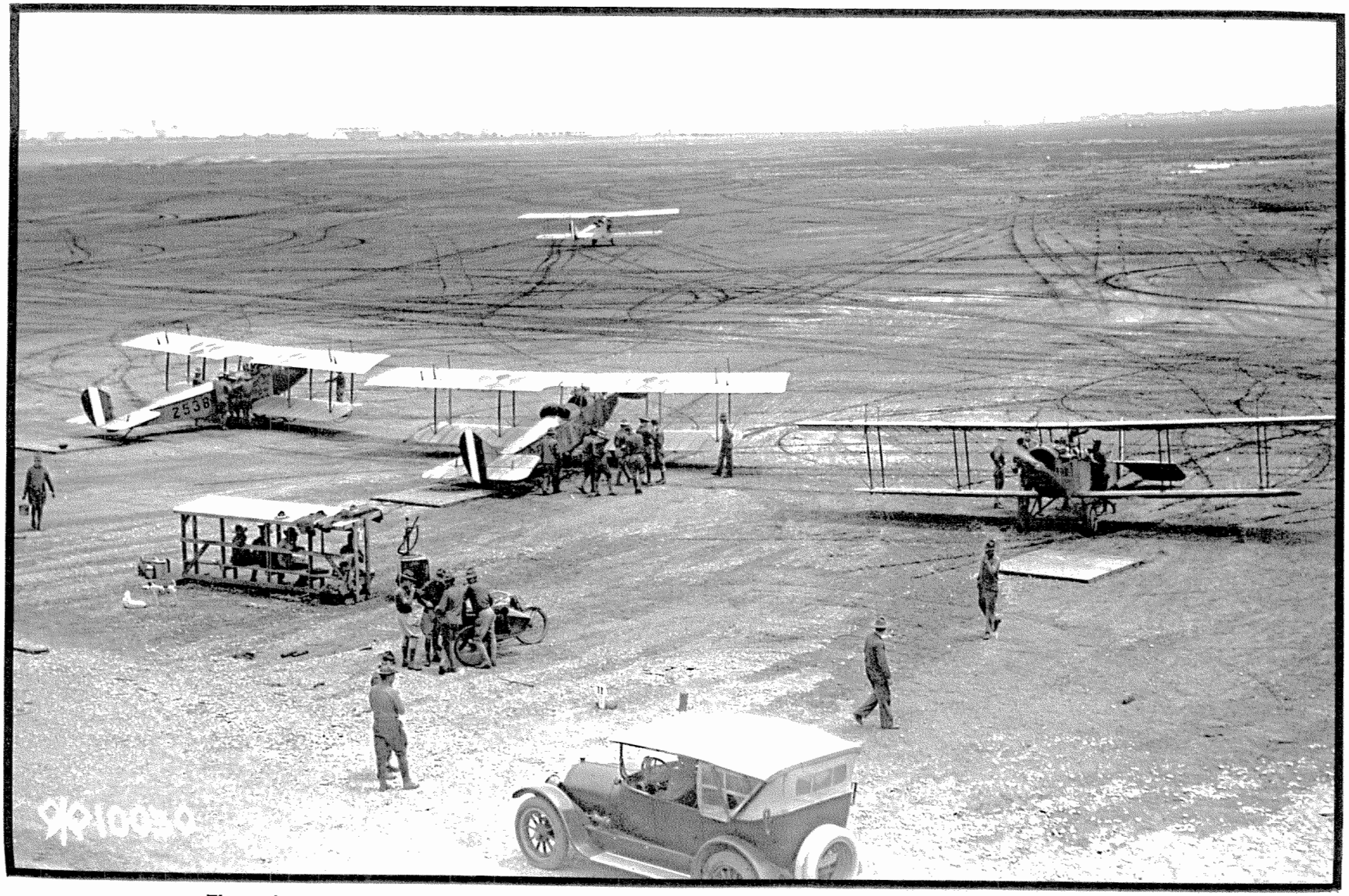

Figure I-8. Flying training at Kelly Field No. 2 during World War I. (Courtesy of the San Antonio Air Logistics Center Historical Office, Kelly AFB)

caretaker status shortly after the war, the remaining sites were used by Army aviators as the only facilities available to them.[34]

Even these temporary buildings marked a significant achievement for Army aviation. As late as 1911, Army aviation consisted of a single airplane, and a small aviation section did not begin until 1913. With the American entry into World War I, however, aviation rapidly expanded in both numbers of men and aircraft. The existence of separate flying fields indicated that in the future, military aviation would move towards greater independence from the ground forces.

Navy

This era also was a time of reform and modernization for the Navy. The modernization initiatives of the 1880s were only a beginning. As of 1889, the Secretary of the Navy estimated the United States ranked twelfth among the naval powers, somewhere below Turkey and China.[35] By 1907, President Theodore Roosevelt could dispatch the Great White Fleet around the world, with a Navy that received the respect of naval power Great Britain. As the United States consolidated control over the territory within its own borders, national attention turned to international politics, trade, and colonization.

The Navy adopted rapid technological changes during this period. Heavily armored steel warships replaced old wooden ships. Wireless telegraphs and radio revolutionized communications. New naval weapons, the submarine and the aircraft, played an important role during World War I, foreshadowing their greater usefulness during World War II.

The history of the shore establishment also reflected these dramatic changes. At the start of this era, the shore establishment consisted of a collection of yards and stations that could not construct a modern warship. It grew into a multitude of bustling facilities, each capable of supporting the demands of a rapidly modernizing, ocean-going fleet. Navy yards and docks expanded to the point where they could construct any type of warship. New research and development facilities opened to test both ordnance and ship design. Old methods of instructing recruits on training ships were replaced with new training stations. Communication facilities, magazines, and coaling stations all added to the complexity of the shore establishment installations.

Steel Ship Construction and Repair

Conversion to steel warships made modern dry docks essential because the new ships required a regular scraping of barnacles off their hulls that only could be accomplished in dry docks. Although improvements were slow at first, the Navy began to upgrade its facilities. By 1890, both the New York and Norfolk yards had new dry docks, which could scrape and clean all but the largest warships. However, the Secretary of the Navy still reported that the New York Yard could not handle its workload with existing facilities. In 1891, the Navy acquired the Puget Sound Naval Shipyard at Bremerton, Washington. Because the channel into this site was deep enough for a battleship, the Navy also built a large dry dock there (Figure I-9). In 1901, the Navy closed its small facility at Port Royal, South Carolina, and replaced it with a yard at Charleston. The first ship used the Charleston dry dock in 1909.[36]

Another function of the Navy's yards was to construct warships. Although most ship construction was performed by private shipbuilders, the Navy Department wanted to maintain a capability to construct ships. As noted earlier, the inadequacy of Navy yards for ship construction became apparent during the mid-1880s when the Navy tried to assume responsibility for the

construction of the first protected steel cruisers. Even the New York Yard could not complete the hulls and engines for the new warships, which forced the Navy Department to complete the work in the contractor's yards.[37]

By 1903, however, the capabilities of Navy yards had improved to the point where the New York Yard could undertake the construction of a first-class battleship, the *Connecticut*. The keel for this ship was laid in 1903 and the final product was completed by 1905, approximately the same amount of time a private builder required to complete a similar ship. This task was a complicated operation for a facility that previously had not constructed a battleship. The ship required hundreds of tons of steel plate to be riveted into frames, precise steam engines, crew quarters, and fittings for the latest weapons and equipment. The New York Yard's ability to complete such a difficult task demonstrated that the Navy yards compared favorably with private contractors.[38]

Even so, most ship construction for the new Navy came from private shipyards. The more generous government wage rates and allowable holidays normally enabled a private builder to operate at a lower price than the government. In his 1905 *Annual Report*, the Secretary of the Navy justified the use of Navy yards for construction by noting the need for competition. "[O]rdinarily, vessels can be built at less expense and more rapidly in private than in Government yards. The Department, however, ought always to have the authority ... to build ... in Government yards, as a protection against extortion or unlawful combination on the part of shipbuilders."[39] In 1915, Secretary of the Navy Josephus Daniels applied this same reasoning to argue that Navy yards should be capable of constructing any type of warship, including the massive *Dreadnought* type of battleship. Daniels also believed that construction activities enabled the Navy to keep a trained work force at its installations.[40]

Regardless of whether a ship was constructed at a private or a government yard, the Navy assumed responsibility for the hull design, and thus added to the shore establishment's growing research and development role. The most significant development in this field was the completion of a one-million-gallon model ship basin at the Washington Navy Yard in 1900. Under the direction of David W. Taylor, the basin was used to test new hull designs to minimize underwater resistance. The basin also was open to private shipbuilders for testing new designs of commercial vessels. With the addition of a wave-making apparatus during World War I, this facility remained in use until 1945.[41]

Development of Naval Ordnance

The new Navy also required new types of ordnance, with both heavier guns and torpedoes. Naval ordnance facilities expanded accordingly as they increased their production capability and conducted more research and development work.

At the beginning of this period, the gun factory at the Washington Yard was substantially improved to undertake the tasks of producing huge guns with precision. By 1892, the Washington Yard ordnance plant manufactured guns up to 13 inches, and by 1898, it was the world's largest naval ordnance factory. During the beginning of the twentieth century, the Washington Yard began to conduct more experimental work, especially to improve gun sights and fire control systems.[42]

The Indian Head Proving Ground continued to perform its missions of proof-firing new guns and conducting experiments to improve the quality of weapons. In 1900, the Navy opened a smokeless powder factory at Indian Head, the first chemical manufacturing plant operated by the Navy. By 1915, the Indian Head plant produced almost four million pounds of powder a year, with the expectation of producing more in later years. This particular activity was justified because

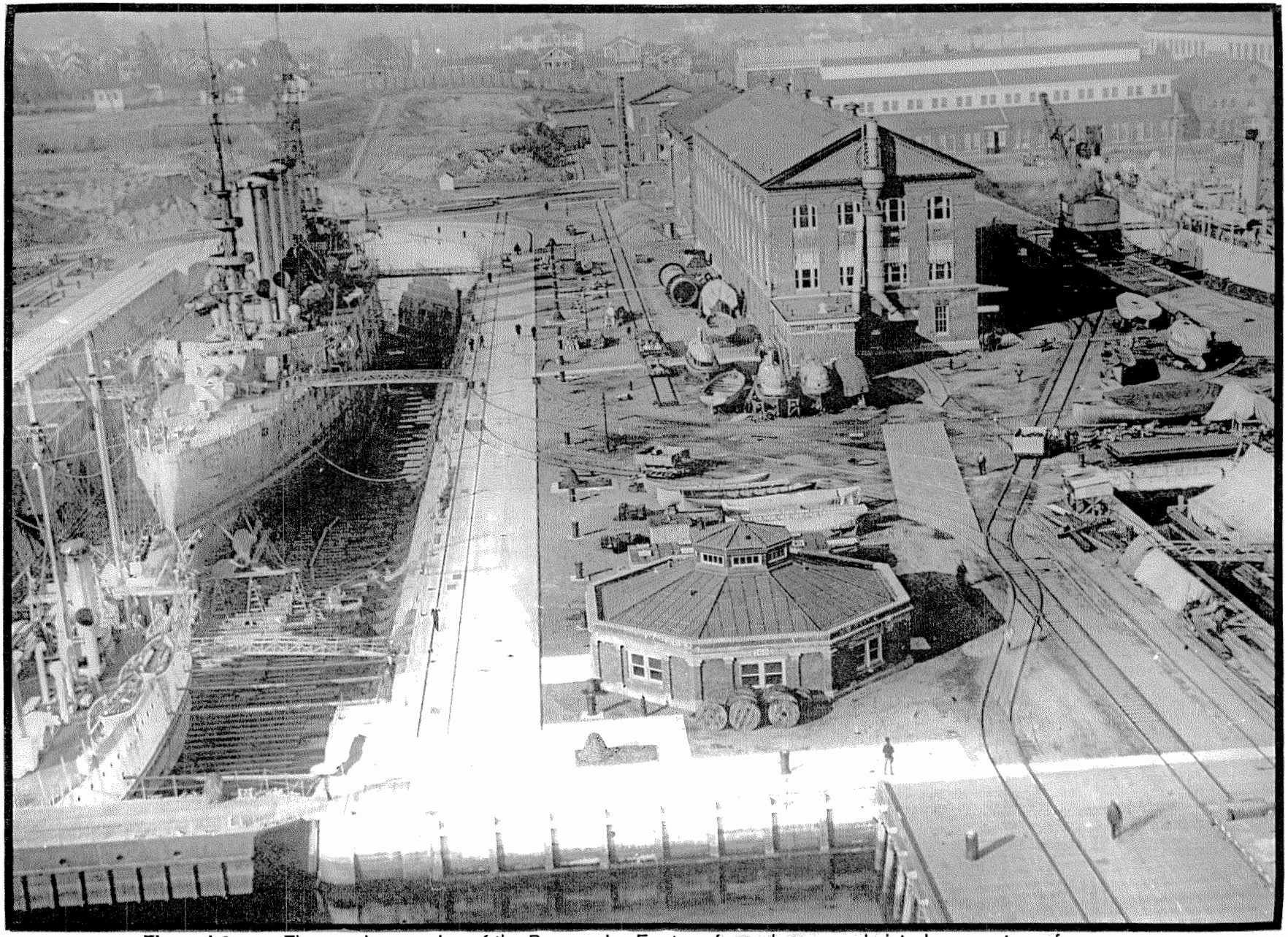

Figure I-9. The naval expansion of the Progressive Era transformed navy yards into busy centers of industrial activity. The 1915 photograph of Puget Sound Navy Yard depicts a dry dock, the dry dock's octagonal pump house, shop buildings, and the marine rail tracks. (Courtesy of the Naval Institute)

of costs. The secretary computed that the Navy could produce powder at about three-fifths the cost of purchasing it.[43] By 1918, work at the Indian Head facility had increased to the point where more testing facilities were required. Consequently, the Navy opened the Dahlgren Annex on the Virginia side of the Potomac River, several miles downstream from Indian Head.

A third ordnance facility, the Torpedo Station at Newport, also engaged in a combination of experimental and manufacturing activities. The term "torpedo" originally applied to stationary underwater mines, but it came to mean the cigar-shaped, self-propelled device today called a torpedo. In 1892, the Navy acquired its first "automobile" torpedoes from a private manufacturer. The Torpedo Station conducted experiments on types or explosives, and vessels to use with the new weapon. During this period, workers at the station experimented with anti-submarine devices, such as the depth charge, and with explosive chemicals and electricity.

By 1908, the government had decided to manufacture its own torpedoes in competition with the private manufacturers. Consequently, the Torpedo Station adopted a dual mission of production and experimentation. It continued to produce torpedoes after the Navy opened another torpedo factory on the waterfront in Alexandria.[44]

Logistical Support to the Fleet

Beyond ship construction and ordnance development, the Navy's shore facilities performed other logistical functions in support of the fleet. Yards and stations always had served as distribution points for subsistence and personal supplies, and they continued to perform this mission throughout this period. However, the modernization of the Navy also placed added logistical burdens on its installations.

The most obvious new requirement was for coal. The Navy had maintained at least some coal supplies since the mid-nineteenth century, when it began to use a combination of steam and sail for propulsion. When steam was an auxiliary form of power, however, the demands for coal were minimal. The huge steel warships of this period had an insatiable appetite for coal that exceeded the Navy's previous experience. The heating surface for the boilers on the cruiser *Minneapolis* covered approximately one and one-eighth acres. Indeed, the Navy required one collier for every four fighting ships.[45]

By 1905, the annual consumption of coal had increased to more than 400,000 tons. To accommodate this demand, the Navy established a series of coal depots. With the preponderance of Navy installations on the East Coast, most coaling stations for the Atlantic and Gulf regions could be located at or near existing Navy facilities, with the exception of one station at Frenchman Bay in Maine. Smaller coal supplies in Cuba and Puerto Rico completed the Navy's requirements for the Atlantic. The Pacific region presented greater problems. The Navy had fewer installations on the West Coast, and larger ships could not use the Mare Island Yard because of its shallow channel. Consequently, the Navy created facilities in Alaska and in the deeper areas of San Francisco Bay. To extend its reach across the Pacific, the Navy also created coal depots in Hawaii, Guam, Samoa, and the Philippines.[46]

The Navy began to establish fuel oil depots in 1910 to supply the needs of submarines and destroyers. Its first fuel oil facilities were located on the East Coast at Key West, Charleston, Norfolk, and Narragansett Bay.[47]

Another logistical requirement of the Navy was for ammunition storage facilities. To meet this need, the Ordnance Bureau expanded an existing set of naval magazines to serve the fleet.

By 1915, the Navy operated six magazines on the East Coast, three of which were within the New York area. Facilities on the West Coast were located at Mare Island and Puget Sound.[48]

The Navy also performed manufacturing functions that today would be performed by contractors. For example, the New York Yard engaged in clothing production. Cloth was cut at the yard, and then assembled by pieceworkers in shops outside the yard. Starting in 1914, the Navy also began to make selected items of clothing at its Charleston Yard.[49]

Officer Education and Recruit Training

Concurrent with the modernization of the Navy came further development of its educational system. Although education of both officers and enlisted personnel improved during this period, the most pronounced changes came in its system of enlisted training. As the Navy began training sailors and recruits in new technologies, it started excluding sailors from technical fields based on race.

The two primary officer education institutions remained the Naval War College at Newport and the Naval Academy at Annapolis. By the beginning of the twentieth century, the Naval War College had become accepted, even admired, by most senior officers. Here, Captain Alfred Thayer Mahan achieved his reputation as a naval theorist by expounding his views on the importance of sea power, and the employment of battle fleets. At Annapolis, the Navy experimented with a limited program for post-graduate education of selected ensigns, in engineering and ordnance.[50]

The most dramatic changes to naval education came with the system for training new sailors. Until 1904, the Navy operated a training squadron at Newport, where recruits received a combination of land-based training combined with cruises aboard sailing ships. In 1904, the Navy finally recognized that sailing ships could not train new recruits in the technically complex duties of the modern Navy. After abolishing the Training Squadron, the Navy established three training stations at Newport, Norfolk, and San Francisco. In 1905, it opened its new facility at Great Lakes, Illinois. Henceforth, recruits received four months training on shore, and then joined the fleet. With minor variations, this system has remained until the present time.[51]

Even this improvement was insufficient for producing sailors with the technical skills required for an early twentieth century force. The Navy then began to expand its specialized training programs beyond the gunnery and torpedo schools operated by the Ordnance Bureau. At the beginning of the twentieth century, the Bureau of Navigation instituted a larger number of schools for specialized training of enlisted personnel. By 1915, the different schools included two electric schools, a machinists' school, a torpedo school, a coppersmith school, a fuel-oil school, an artificer school, two yeoman schools, two commissary schools, two musicians' schools, and a mess attendants' school. During the fiscal year 1915, 1,302 sailors graduated from one of these schools, which were located at the Norfolk, Philadelphia, New York, Charleston, and San Francisco naval yards.[52]

Partly as a result of increasing racial segregation and partly as a result of the increasing technological sophistication of the Navy, African-American sailors found their careers curtailed. Since the War of 1812, the Navy had accepted black sailors on an equal basis with whites. Traditionally Navy or merchant sailing ships had used African-American or white sailors, with few distinctions based upon race. Towards the end of the nineteenth century, this practice began to change. Unwilling to give African-Americans authority over white sailors, the Navy stopped promoting black sailors to petty officer. In theory, an African-American could apply for a commission on the same basis as a white, but in practice, all Navy officers were white. African-Americans were more often assigned to mess duties, instead of traditional deck duties, a practice

that also allowed for segregated sleeping quarters and limited the opportunities for black sailors to learn the new technologies of a steel navy.

A severe blow to the status of African-American sailors came with the voyage of the Great White Fleet around the world in 1907. The Navy had used Japanese as officers' servants. Yet Navy officials now feared that deteriorating relations with Japan might cause the Japanese servants to sabotage the ships. Consequently, they dismissed the Japanese and reassigned African-American sailors to duties as officers' servants. Henceforth for much of the twentieth century, African-Americans in the Navy primarily were limited to duties as mess attendants and servants.[53]

The new training systems, despite the limitations on their enrollment, proved to be effective in meeting the challenges of World War I. Although the Navy's manpower requirements were not as massive as the Army's, the Navy underwent its greatest expansion since the Civil War. From January 1917 to November 1917, the Navy grew from 4,500 officers and 68,000 enlisted men to 15,000 officers and 254,000 enlisted men. The bulk of the new recruits were trained at the four existing training stations, which were expanded by the addition of temporary facilities. Other recruits were trained at camps placed on existing installations. The Navy acquired a few temporary camps, such as Pelham Bay, New York, and Bumpkin Island near Boston, but it generally preferred to use its existing facilities. The new camps were either wooden structures or tents with water, sewage, and other utilities. A few civilian colleges and universities contracted for special purpose training completed its wartime training functions.[54]

Personnel Support

Personnel support functions also began during this period. Throughout the nineteenth century, Navy yards were designed to provide supply and maintenance support to the fleet, and therefore were primarily industrial facilities. The first indication of a development of personnel support functions came in 1905, when the Navy announced a policy of assigning a home port to each ship in the fleet. Among other reasons, the new policy was expected to ease the burden on sailors and their families. The use of home ports encouraged families to live near installations and they began to receive support from the facilities. In 1909, Congress authorized service members to purchase subsistence goods from the installation commissary departments, giving rise to the Navy retail commissary system. Another step towards using installations for the benefit of the service members came with the Sixth Division of the Bureau of Navigation in 1918. This organization was assigned to improve the morale of enlisted personnel. Part of its responsibilities included developing morale, welfare, and recreation facilities on the installation by providing athletic equipment, theaters, and canteens.[55]

New Technology: Submarines, Aircraft, and Radio

During this period, new technologies were introduced that revolutionized naval warfare. Two new types of weapons appeared during this time: the submarine and the airplane. Since both weapons were in the experimental stages, their revolutionary effects on naval warfare came later, during the two world wars. New methods of communication had an equally significant effect on naval warfare.

The first submarine to enter the Navy inventory was the *Holland*, built by the Holland Torpedo Boat Company in 1900. During the first decade of the twentieth century, the Navy purchased other models, all of which were small, gasoline-driven boats. Many officers considered them to be more dangerous to the crew than to the enemy. During World War I, however, the German Navy demonstrated their devastating effect on enemy commerce.[56]

The Navy converted a minor coaling station at New London, Connecticut, into its first submarine base. The first submarines, and a tender, were stationed at New London in 1915. The installation was declared a submarine base in 1916, and a submarine school was established at the same time. During World War I, the school and base rapidly were expanded, with more than 10,000 men trained at the school.[57]

Naval aviation began in 1910, when Lieutenant Eugene Ely flew an aircraft from the cruiser *Birmingham*. In 1911, he made his first successful shipboard landing on the *Pennsylvania*. Navy leaders quickly recognized the usefulness of aircraft for reconnaissance, and authorized further experimentation. Such experiments included demonstrations of seaplanes in New York's Finger Lakes and aviation participation in fleet exercises near Cuba in 1913. Until 1914, the Navy operated a flight school at Annapolis; in that year, it opened its aviation school at Pensacola, Florida. Despite these efforts, U.S. Navy aviation in April 1917 was quite small, consisting of 48 pilots and 239 enlisted men, with 54 aircraft.[58]

The German submarine menace of World War I provided the first wartime application of naval aviation. Aircraft, especially seaplanes, proved to be an effective anti-submarine weapon. Consequently, Navy aviation units either moved to France to patrol the eastern Atlantic, or patrolled the western Atlantic from stations in the United States. Naval aviators in France were credited with attacking 30 German submarines and the sinking of 10. They also contributed to the destruction of other submarines by directing destroyers towards the enemy. In another effort to counter enemy submarines, the Navy organized a Northern Bombing Group, which attacked submarine bases in Belgium.[59]

The Navy shore establishment's largest contribution to the wartime aviation effort came through its training facilities. Even with its expanded facilities, the Pensacola School only could train a fraction of the necessary aviators and ground support personnel. Temporary training stations were opened as rapidly as possible, and were supplemented by courses established at civilian universities, especially the Massachusetts Institute of Technology. In time, the Great Lakes Training Station expanded its operations to cover aviation-related courses for both officers and enlisted personnel.[60]

The Navy also built an aircraft factory in Philadelphia. Like its other industrial facilities, this factory was intended to produce only a portion of the required aircraft. The Navy wanted an aircraft factory to build experimental aircraft when necessary, and to obtain cost data to evaluate bids from private contractors.[61]

During the late 1890s, the Italian inventor Guglielmo Marconi developed a system for transmitting signals using radio waves, which became the first wireless telegraph. During the following years, inventors improved upon Marconi's invention to increase the reliability and range. They even succeeded in superimposing sound waves on the wireless signals to produce the first voice radio. The Navy initially was somewhat indifferent towards electronic communications, but as the reliability of the radio increased, Navy officers recognized its potential to change naval warfare. A 1904 presidential directive enabled the Navy to install wireless telegraph facilities on its ships and shore stations, making it possible to pass weather reports and other information to commercial ships. In 1905, the Navy reported that 23 shore stations had wireless equipment, with another 13 stations building new facilities. Within a decade, the radio eclipsed the wireless telegraph. The first transcontinental radio message was transmitted by the Navy, with the Army's assistance, from Arlington, Virginia, to Mare Island, California, in 1915. In 1919, the Navy had almost 150 radio stations scattered throughout the United States and its territories.[62]

World War I Navy Construction

With the nation's entry into the First World War, the Navy's activities expanded with extraordinary rapidity, but in different ways than had been planned before the war. Since the modernization of the Navy, strategic thinking had stressed battleships and surface battles. Now, the German submarine menace required an emphasis upon smaller ships and convoy escort duty. The Navy met this challenge with a convoy system that escorted 450 transports across the Atlantic, with only 8 losses.[63]

Expansion of the fleet also required expansion of the Navy shore establishment. The Navy, like the Army, conserved available resources through stringent economy measures. Wherever feasible, buildings were temporary, wooden buildings, not intended to last beyond the duration of the war. The heavy industrial functions of Navy shore facilities required more permanent construction than was necessary for other wartime military construction. Temporary frame buildings were not suitable for heavy industrial use.

One of the most pressing wartime requirements was the construction of training installations to accommodate the influx of new sailors. To meet these requirements, the Navy planned a rapid expansion of existing training stations and the addition of training camps to other Navy installations. These additions generally consisted of hastily constructed temporary barracks, designed to provide a minimum standard of shelter to recruits. To augment these training camps, the Navy Department often leased civilian facilities, such as schools, and occasionally built dormitories as necessary.[64]

Ship repair and service facilities were not constructed so readily. The Navy began to prepare for expansion of its yards in 1916; plans for these facilities were approved before the United States entered the war. These plans called for new dry docks and supporting industrial facilities. As the United States entered the war, a massive construction program at existing Navy yards was initiated, at a final cost of over $210,643,000.00. Typical improvements included slips for building ships, machine shops, structural shops, cranes, and related industrial buildings.[65]

Unlike the training camps, shipyards required permanent construction. Shop buildings utilized structural steel frame clad in tile, concrete, or brick. Foundries contained overhead cranes, which necessitated walls strong enough to support the weight of the cranes, thus precluding temporary construction. Machine shops were either light machine shops, which could be multi-story, or heavy machine shops, which were described as mammoth steel buildings, containing large aisles for heavy machines. Other steel structures for Navy yards included steel shipbuilding slips, launching ways, and large cranes; all intended for the construction or repair of warships.[66]

In 1917, the term "operating base" entered the Navy's lexicon with the creation of the Norfolk Navy Base, a new type of installation and one of the most ambitious wartime projects. In 1917, the Navy acquired the site of the celebration of the 300th anniversary of Jamestown colony, located near Norfolk, Virginia. The new Norfolk Base was the rendezvous point for the Atlantic Fleet. It provided all logistical and personnel support functions, except ship construction and repair. Among the features included at the base were storage facilities, drill and training facilities on shore, barracks for the enlisted personnel, and a large auditorium. A naval aviation station also was constructed at the Norfolk Naval Base during World War I.[67]

Entrance into the war also multiplied the activities of the Navy's Ordnance Department, which had responsibility for production of weapons and ammunition, storage of ammunition, and testing activities. Such activities required a proportionate increase in the facilities of the Ordnance Department, which was normally accomplished through the expansion of existing installations. Physical improvements were undertaken at the Navy's ammunition depots, the Naval Gun Factory

in Washington, the Powder Factory in Indian Head, and the various torpedo stations. The buildings added to the ordnance activities were functional designs characterized by contemporary industrial design without references to historical styles. The Navy also constructed several new Ordnance Department installations, which would play an important role in the Navy's later history. These additional facilities included a new proving ground at Dahlgren, Virginia, a mine depot at Yorktown, Virginia, and an armor and projectile factory in Charleston, West Virginia.[68]

To meet the storage and distribution requirements for its expanded fleet, the Navy also added to its warehouse capabilities. This expansion took the form of adding new warehouses to existing yards and stations, plus the establishment of two new Fleet Supply Bases at Brooklyn, New York and Norfolk, Virginia. Construction consisted of a combination of permanent and temporary buildings. The permanent buildings were generally multi-story warehouses, constructed from reenforced concrete, while the temporary buildings were wooden warehouses.[69]

The Navy's contribution to the Allied victory in World War I marked a significant milestone in the growth of the American Navy. Within a single generation, the United States emerged as one of the world's leading naval powers. Moreover, it accomplished this feat at a time when naval technology was changing rapidly. This time was noteworthy for its rapid growth and change for both the fleet and shore establishment. The history of navy installations reflects these changes, as the shore establishment acquired the sophistication to support a modern fleet.

Marine Corps

During the Progressive Era, the Marine Corps appeared as a separate fighting force that could operate with its own formations. Prior to that time, its most important functions were to provide marine complements aboard warships and to guard Navy installations. Some Navy officers questioned its usefulness in performing even these functions. By the end of this period, Marines had acquired new missions of defending advance bases, performing large-scale intervention in Asia and Latin America, and providing a Marine Corps brigade for service during World War I. In conjunction with the appearance of distinctive Marine Corps missions, the Marines also developed their own installations.

Ships Complements

During the closing years of the nineteenth century, the Marine Corps remained a small organization with limited missions. It continued to guard Navy yards and to provide guard details for warships. The Marine Corps' duties on ship included manning the secondary guns, forming landing parties, and maintaining discipline aboard ships. The Marines performed credibly in the first two functions. From 1889 to the Spanish-American War, they landed eight times in Latin America and Hawaii to protect American merchants and legations, usually for short periods of time. The Marines performed more substantial service in China and Korea, often performing landing duties for months at a time. They were renowned for their seizure of Guantanamo Bay during the Spanish-American War.[70]

The Marines earned the resentment of both Navy officers and sailors for their role of enforcing ship's discipline. Progressive Navy officers believed that enlisted men did not require coercion, and that the Marines' presence merely aroused the resentment of sailors. Tensions between the Marine Corps and the Navy grew during the 1890s. When President William McKinley selected a Marine officer as his naval aide, no Navy officer would serve with him. By 1908, Navy officers persuaded President Theodore Roosevelt to sign an executive order delineating Marine Corps missions as protecting Navy installations, but not as ships guards. The Navy immediately

began to dispense with its Marine complements, and it was rumored that the President would propose to abolish the Marines. Marines responded with an appeal to Congress, which attached a rider to the 1909 appropriations bill mandating Marine complements for warships. With this Congressional support, their future seemed assured.[71]

Foreign Intervention

Even as the Marine Corps struggled to preserve its presence on warships, Marines began to assume new missions. American intervention in foreign affairs increased dramatically following the Spanish-American War. The Marine Corps' experience in the limited foreign intervention of the late nineteenth century made them especially suitable for the more substantial intervention of U.S. foreign policy during the early twentieth century. Furthermore, the Navy's insatiable appetite for coal required the creation of naval bases in the Pacific, and these bases required the protection of the Marine Corps.

One of the most publicized interventions of the Marine Corps came with the Boxer Rebellion in 1900. In response to urgent pleas from American residents in China, Marines from the *Oregon* and the *Newark* rushed to Peking and joined other western military forces in protecting the foreign legations during a siege by the Chinese. The Marine Corps participated in the relief expedition organized by Japan and the western nations to relieve their legations under attack in Peking. Even after the conclusion of the Boxer Rebellion, the Marines remained in China until World War II.[72]

China was not the only arena for the Marines at the beginning of the twentieth century. They continued to enter foreign nations, in strengths ranging from battalion to brigade. Marines fought in the Philippine insurrection. They intervened in a Panamanian rebellion against Columbia. Beginning in 1913, they began a prolonged intervention in Haiti. Some smaller landings included Ethiopia, Honduras, Syria, Santo Domingo, Tangier, Korea, and Cuba.[73]

Installations and Schools

As it began to operate in distinct formations, the Marine Corps also acquired its own installations and schools. Although the majority of the Marines during this period were stationed at Navy facilities or on ships, the Marine Corps began to acquire real estate for its own purposes. Two such examples are the Marine Corps Depot at Philadelphia, and the rifle range at Winthrop, Maryland.

In 1903, Congress authorized a Marine Corps Depot in Philadelphia, which was completed in 1905. The depot's primary functions were the manufacturing of Marine Corps' special uniforms and equipment, and storage of all types of Marine Corps supplies. As such, it became indispensable to the support of Marines in the Atlantic and Caribbean. Marine units dispatched on expeditionary duty were organized at Philadelphia. The commandant expressed a desire to train recruits in Philadelphia, and he moved an officers' Advanced Base Course to that city.[74]

Another prototype for a modern Marine Corps installation was the rifle range at Winthrop, Maryland. Although the range was located at the Navy's Indian Head Proving Ground across from Mattawoman Creek, the Marines referred to it as Winthrop. They stationed a small number of Marines at the site, with appropriate facilities. It was used to train Marines stationed on the East Coast from Philadelphia to Charleston. This rifle range was one more indication that the Marines were acquiring their own real estate as training areas. The barracks, as adjuncts to Navy installations, no longer were sufficient.[75]

Until 1915, Marine recruits trained at Norfolk or Mare Island. The opportunity for a separate training facility came when the Navy opened a yard at Charleston, South Carolina, and reduced its operations at Port Royal, South Carolina. By 1915, the site was a Navy disciplinary barracks with excess land. The Marine Corps had experimented with recruit training at Port Royal in 1910, and in 1915, the Corps opened a permanent recruit training center at the Marine Corps Barracks, Port Royal. The site later would be known as Parris Island.[76]

During this period, the Marine Corps also began to establish their own school system for officers' professional development. General Heywood, Commandant of the Corps, had established a School of Application at the Marine Corps Headquarters. This step was followed by the creation of a Marine Officers' School at the Navy Station in Port Royal. By 1915, Marine Corps schools included the Advanced Base School in Philadelphia, a Field Artillery School in Annapolis, and a Machine Gun School in Pensacola.[77]

World War I

During World War I, Marines not only continued to support the Navy, but Marine Corps units served with the American Expeditionary Force. The Corps raised a brigade of Marines and sent it to France, where it became a brigade of the Army's 2nd Infantry Division. During the hard fighting of Belleau Wood, the Marines distinguished themselves and earned favorable publicity in the American press.

Marine Corps aviation also received its first combat experience in World War I. Although a few Marine Corps officers had trained at Navy and Army schools since 1912, aviation remained a minor part of the Corps. During the war, Marine Corps aviation began to function in its own units. The senior Marine Corps aviator, Captain Cunningham, originally planned to operate in support of the Marine Brigade, but Army authorities refused to accept this plan. Marine aviators flew with the Northern Bombing Group against German submarine bases, while other Marines flew antisubmarine patrols.[78]

In order to train the new recruits, the Marine Corps expanded its training program at Parris Island. Here, the Marine Corps instituted a 12-week basic training course that established the Marine Corps' reputation for tough training. When they were not being trained in military subjects, recruits scooped oyster shells to pave roads. Water was carried to the island by barge and was rationed, except for drinking and cooking.[79] In the words of one 1917 recruit: "The first day I was at camp I was afraid I was going to die. The next two weeks my sole fear was that I wasn't going to die. And after that I knew I'd never die because I'd become so hard that nothing could kill me." The training system worked so well that it became permanent.[80]

To meet other demands of the European war, the Marine Corps established another base on the Potomac River, at Quantico, Virginia. Here, the Marine Corps conducted advanced training for officers and enlisted men, and created a replacement depot for personnel going overseas. During the war, Quantico consisted of tents mired in mud. Permanent construction at the site came after the war.[81]

The Marine Corps began this period with attacks on its role as ships complements, and rumors that the Navy wanted to disband the organization. It survived by accepting new missions and in the process began to operate in regiment and brigade size formations. As such, the Marine Corps achieved greater independence from the Navy, including its own installations.

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CHAPTER 4
THE INTER-WAR YEARS, 1918-1940

With the close of World War I, American interest in military affairs declined sharply. The war left an enormous debt that limited military expenditures. When the apparent prosperity of the 1920s ended in one of the worst depressions in U.S. history, the public correspondingly was unwilling to spend money on the military.

During the 1920s, international events seemed to support the belief that large armed forces would be unnecessary in the future. After their disastrous experiences in the war, European nations formed the League of Nations in an effort to solve their disagreements peacefully. The Washington Naval Disarmament Conference of 1921 - 1922, followed by the London Naval Disarmament Conference of 1930, provided further confidence that future conflicts could be avoided through limiting Pacific fortifications and the ratio of capital ships. In the Kellog-Briand Pact, world powers renounced war as an instrument of national policy. Only with the rise of international tensions during the 1930s did this hope for permanent peace prove to be illusory.

For the military, this time was one of mixed progress. All services languished under restricted appropriations and slow growth, yet they also developed patterns that produced the victorious military during World War II. Improvements in technology, especially aviation, were integrated into the services. Officers who emerged as leaders of World War II received their training during these years.

Strategic planning was dominated by the colored plans. Under this scheme, Army and Navy War College planners developed a variety of contingency plans for each possible enemy. Each potential enemy received a different color designation: RED for Britain, GREEN for Mexico, BLACK for Germany, and ORANGE for Japan. Plans to fight combinations of enemies were designated as RAINBOW plans.

Army

In many respects, the Army grew very slowly during the inter-war years. Because the nation did not foresee significant conflicts, the military operated under severe budget constraints until the late 1930s. The Army implemented some important administrative reforms and experimented with new technology on a limited scale. Despite the general lack of interest in the military, Army installations undertook a coordinated effort to improve the design of deteriorating World War I cantonments. One of the most conspicuous achievements of the Army during these years was the physical improvement of its installations. With congressional authorization, the Army disposed of its unnecessary installations and constructed some of its most comfortable posts during this time. The Army survived these lean years until the Protective Mobilization phase that preceded U.S. involvement in World War II.

War Planning and Institutional Development

Following its demobilization, the Army returned to a peacetime strength of 19,000 officers and 205,000 enlisted personnel. During the early 1920s, the number of troops fell below 150,000. With the expectation that wars would be avoided, civilian and military leaders believed this force was sufficient to guard the United States and to form a nucleus of a military organization in the event of war. This reduced force required no new installations; older installations were retained as corps area headquarters or for summer training. The Defense Act of 1920 further clarified the

Army's peace time roles by establishing nine corps areas within the continental United States, with each Corps to contain one active Army division, plus one Reserve and two National Guard divisions. The same act established an Air Service, a Chemical Warfare Service, and a Finance Department.[1]

At the close of World War I, this reduced Army structure appeared appropriate for the international situation. During the 1920s, Germany was a democratic nation. Japan posed a more serious threat to American interests, especially the Philippines, but it had not yet entered its protracted war with China. As late as 1924, students at the Army War College studied plans for a war against a combination of Great Britain and Japan called the RED/ORANGE scenario.[2] The United States had its differences with Britain after World War I, but the possibility of a war had been minimized by the Washington Naval Disarmament Conference of 1921.

By the 1930s, both Germany and Japan had become sufficiently serious threats to demand the attention of Army leaders. When Douglas MacArthur became Chief of Staff in 1931, he directed the Army General Staff to focus their planning on "probable conflicts," especially a war with Japan. He wanted to shift the emphasis from the defense of the continental United States towards an "Immediate Readiness Force." When Malin Craig succeeded MacArthur in 1936, he placed even more emphasis on near-term preparations for war. By this time, Nazi Germany had emerged as a real threat to European peace, and Japan had entered its war with China. Craig developed the "Protective Mobilization Plan" for using Regular Army and National Guard forces in a war.[3]

The lack of appropriations hindered actual improvements. Even after the United States began to increase its military appropriations during the late 1930s, the Navy received the first appropriations. Craig cut research and development programs to pay for more weapons, but the funds remained short. The Army improved its coastal defenses in the Pacific, especially San Francisco, Hawaii, and the Philippines; however, increasing international tensions did not produce significant numbers of new Army installations, or significant quantities of temporary buildings until after the war in Europe began.[4]

Technologically, the Army experimented with new weapons, but also preserved its old weapons. Beginning in 1928, the Army experimented with tanks at Camp Meade, until MacArthur allowed armored developments to lapse under the indifferent direction of infantry and cavalry branches. Although the Army incorporated motor transportation into its inventory, the horse cavalry and horse-drawn artillery also remained in the Army until World War II. With large quantities of World War I surplus material still in its supply system, the Army seldom invested in new equipment. Even though the technology for a semi-automatic rifle was available, the bolt-action Springfield '03 remained the standard rifle until 1936.

Installation Improvement

Army installations initially suffered from the neglect of the post-war years. Following the war, the Army had retained a significant number of its World War I cantonments. Lacking funds for proper maintenance, let alone improvement, the installations fell into disrepair. At Ft. Benning, officers and enlisted personnel were sheltered in tents or primitive shacks through the early 1920s. Wartime temporary buildings had outlived their usefulness, and soldiers complained that their quarters failed to keep them warm in winter. Their officers feared danger from fire. In 1925, the Secretary of War complained in his *Annual Report* that "No graver problem faces the War Department to-day than that of providing adequate shelter. The officers ... are in constant dread of ... [fire] in the groups of temporary wooden buildings ... even greater than their apprehension of fire in quarters and barracks is their dread of a serious fire in the ... hospitals.[5]

In 1926, Congress took the first step towards improving the condition of Army posts by enacting Public Law No. 45, which authorized the Secretary of War to dispose of 43 military installations, or portions thereof, and to deposit the money received from sales into a special fund designated the "Military Post Construction Fund" to towards construction at the remaining posts. Prior to that time, surplus posts were transferred to the Interior Department, with none of the proceeds going to the War Department.[6]

Appropriations for the first year were too small for the War Department to make substantial improvements. Consequently, Army leaders decided to limit the first year's projects to improving enlisted barracks and hospitals. To avoid contention between branches, the Army further divided the money among the Infantry, Signal, Air Corps, and other branches of the Army. Within these guidelines, the Army concentrated their efforts on those installations with the most serious deficiencies.[7]

During the following years, the Quartermaster Corps changed its emphasis from improving single buildings to wholesale landscaping of installations. The Quartermaster General employed a group of distinguished landscape architects, both uniformed and civilian, to apply the latest techniques in city planning to Army posts. Remaining World War I cantonments particularly received the benefit of the new "garden city" and "city beautiful" movements in urban planning.[8]

The new team of planners, including George B. Ford and First Lieutenant Howard Nurse, believed that a post design should be harmonious with the natural surroundings, while simultaneously offering a unity of design and utility. As Ford noted, there "seemed to be a feeling that any building or layout that was not foursquare and austere was effeminate and unworthy of the Army. ... Fortunately it is now a thing of the past, relegated to the junk heap along with the blunderbuss and battering ram." The new architects allowed for maximum use of open space near the public parts of the post, while accepting irregular street patterns where appropriate.[9]

Individual buildings were designed for maximum comfort of the occupants. Enlisted barracks were built for up to four companies, or 450 soldiers. When feasible, they contained three floors with the first floor reserved for administrative, recreational, and messing functions. Funding for officers' housing was placed at $14,500.00 for field grade officers and $12,500.00 for company grade officers, a sufficient sum to allow construction of masonry houses, often with two stories. Where room was available, houses were erected on single lots; otherwise, they were placed in duplex quarters. The Quartermaster Corps also decided to incorporate regional architecture in its standardized designs. Generally, the Georgian or Colonial Revival style prevailed in the northeastern states, while Spanish Mission architecture was deemed most appropriate for the southern regions (Figure I-10).[10]

During the depression of the 1930s, construction projects on Army posts continued. By using the Works Progress Administration (WPA) and Public Works Administration (PWA) programs to provide employment, the Army continued to improve its installations while other military funds were reduced.[11] At times, however, the Army needed to employ unusual techniques to accommodate the WPA workers. For example, workers at Ft. Knox were transported by special train to their work site, where they were temporarily housed by the Army for two weeks and then returned home.[12]

Many new posts allowed the Army to concentrate larger units at one installation, or to use larger training areas. Although small by late twentieth century standards, Army posts had increased to the point where some installations could house a brigade. The Signal Corps favored Ft. Monmouth, New Jersey, as a site for its school because students could conduct maneuvers, including laying wire over its comparatively large acreage. Ft. Bragg, North Carolina, was large enough to contain an artillery range. The Army intended to place a brigade at Ft. Devens,

Massachusetts, and "to get as much of the Third Division at Camp Lewis as it is possible to get."[13] One measure of the increase in size of the new posts was size of the new barracks building. A standard barracks constructed in 1928 housed four infantry companies, or about 400 soldiers. In 1894, an entire installation contained between 60 and 750 soldiers.[14]

Training, Coastal Defense, Schools, and Logistics

Functionally, Army installations followed patterns established during the pre-war years. They served as garrisons for line units, coastal defense sites, facilities for Army schools, and logistical installations. With the development of military aviation, some sites became Air Corps fields, either in whole or in part.

Although Army posts had always served as garrisons for line units, the distribution of units was changed by the National Defense Act of 1920. Prior to that time, the Army was divided into departments according to geographic criteria, with a large portion of units stationed in the West as a remnant of Native Americans conflicts. In 1920, Congress replaced the territorial departments with nine corps areas.[15]

With the severely diminished size of the Regular Army, military leaders recognized that future manpower needs would require mobilization of citizen soldiers. Therefore training of the Army's so-called "civilian components" became an important function for military posts during the inter-war years. In 1933, a survey of buildings at Army posts identified approximately 63 installations where some type of summer training was conducted. The examples of Ft. George G. Meade, Maryland and Ft. Knox, Kentucky are probably typical. Both installations used Regular Army soldiers to train National Guard units, R.O.T.C. cadets, and C.M.T.C. volunteers. The R.O.T.C. (Reserve Officers Training Corps) program trained college students to receive an Army Reserve commission upon graduation. The C.M.T.C. (Citizens Military Training Camp) accepted young men of high school age to undergo voluntary military training. At both Fort Meade and Fort Knox, C.M.T.C. training became elaborate affairs, with a combination of military training and recreational opportunities.[16]

In the coastal defense arena, the trend towards greater dispersion of guns continued. Some new batteries contained guns of up to 16 inch caliber, sometimes placed as far as 1,000 feet apart and connected through small railroads. Other large weapons were mounted on railroad cars to be moved as the situation warranted. In 1937, the Coast Artillery constructed a new type of fortification at San Francisco that housed the gun battery under an overhead cover, with similar covers for the ammunition facilities. The Army followed with similar batteries within the Pacific region. As the potential for air attacks increased, the coastal artillery also acquired the mission of anti-aircraft fire, which in time allowed the Coastal Defense Artillery to evolve into the Air Defense Artillery.[17]

The military school system by this time included 31 special service schools for providing training in a specific branch, i.e., Infantry, Ordnance, Engineer, etc. Posts such as Ft. Benning, Ft. Sill, and Ft. Riley became important as the homes of the Infantry, Artillery, and Cavalry schools, respectively. Other installations housed special schools in addition to their other missions. For example, the Quartermaster Corps operated a Motor Transport School at Camp Holabird, near Baltimore, Maryland, which was also the site of a motor transport storage depot and repair facility. The senior service schools consisted of the Command and General Staff College, the Army War College, and the new Army Industrial College.[18]

Ordnance Installations engaged in fewer production activities due to the wartime surplus of material and the stringent economic measures of the period. They compensated by increasing

Figure I-10. 1930s example of Quartermaster standardized Colonial Revival officers' quarters at Ft. Knox, Kentucky.

their research and development activities. Rock Island Arsenal, for example, specialized in improving artillery carriages that could absorb the weapons' recoil. This arsenal pioneered the use of welding and fine machine work to improve recoil mechanisms. Picatinny Arsenal in New Jersey produced smokeless powder and high explosives until 1926. Ammunition production halted suddenly in 1926 when an explosion at the adjacent Lake Denmark Navy ammunition depot damaged the Army's production facilities. The War Department rebuilt Picatinny Arsenal, but shifted its missions towards research and development of explosives.[19]

Army Air Corps

Because the Air Corps remained part of the Army during these years, the history of its installations parallels that of the Army. The same acts of Congress that provided for improvement of Army posts also provided for the improvement of Air Corps fields. The highly visible drive for independence by Army aviators and rapidly changing aviation technology also stimulated congressional interest in the Air Corps and its installations. The result was a slightly different pattern of development for Air Corps fields.

For Army aviators, the inter-war years brought both progress and frustration. Their desire for a separate Air Force, equal to the Army and Navy, was not realized until after World War II. Yet military aviation progressed remarkably during these years, and Army aviation achieved greater autonomy within the Army. As part of the development of the Air Corps, its installations also improved remarkably. As of 1918, Army flying fields consisted of temporary buildings, with sod or gravel runways. By 1940, these fields contained permanent housing with hard-surface runways and the necessary facilities to maintain aircraft. Several installations acquired distinct missions, most notably as schools or logistical facilities. These developments laid the groundwork that allowed Army aviators to exploit more fully the military potential of aviation during World War II.

Towards a Separate Air Force

Although Army aviation achievements during World War I had ensured that aviation would remain a vital part of the Army, leading Air Corps officers wanted a separate, independent air force. The essence of their argument was the potential of air power as a strategic weapon versus as a tactical weapon. Army generals generally welcomed aviation as a tactical weapon, that is, in support of ground operations. Led by Billy Mitchell, Air Corps officers wanted to employ air power as a strategic weapon by using massive bomber formations to reach into an enemy homeland and defeat the enemy without resorting to ground warfare. Because Air Corps officers believed conventional Army leaders could not understand or employ the full possibilities of air power, they pushed for a separate Air Force.

The tactics of Mitchell assured a high level of interest in the controversies between aviation and ground officers. Mitchell's outspoken criticisms of military leaders eventually resulted in a well-publicized court-martial that in turn prompted endless boards of inquiry and congressional hearings on the Army Air Corps. Although the Air Corps leaders failed to achieve independence from the Army, they did find funding for many of their objectives, including new aircraft and installations.

By 1935, Air Corps officers came further to the realization of a separate service with the creation of a General Headquarters (GHQ) Air Force. The organization contained a headquarters at Langley Field and three subordinate wings at Langley, Barksdale, and March fields. The purpose of the GHQ was to command selected air units so that they could be employed according to Air Corps doctrine. Army Corps commanders still retained command of aviation

units in support of their corps. The Chief of the Air Corps retained responsibility for training and administrative support to Army aviation.[20]

Although the new organization remained a subordinate command within the Army, it did give aviators a greater degree of autonomy. They used this freedom to develop their interest in long-range bombers. Early versions of multi-engine, all-metal bombers had entered the Air Corps inventory during the 1930s, culminating with the introduction of the B-17 in 1935.[21]

New Construction of Air Corps Installations

At the close of World War I, Army flying fields consisted primarily of installations created for the emergency. Some of these fields were parts of larger posts, while others were entirely flying fields. Only Langley Field, Virginia, and Rockwell Field, California had permanent buildings. Others contained temporary wooden buildings and gravel landing strips. Construction had stopped at the close of the war, although the fields were only half-finished. From 1918 to 1925, the Air Service survived under these conditions, with no appropriations available for improving the sites. Conditions were notoriously bad at Selfridge Airfield, near Detroit, Michigan, where cold weather made the poor quarters unbearable.[22]

Physical improvement of the air fields began in 1926 under the same conditions and legislative actions that affected other Army posts. As part of the Army, the Air Corps received its share of money towards post construction. Throughout the inter-war years, the legislation on installation improvement also applied to aviation.[23]

Because Army airfields had first appeared in significant numbers during World War I, the need for permanent housing was more acute. In 1927, Assistant Secretary of War Trubee Davison expressed the Air Corps' special needs for better housing.

> I found that much of the Air Corps personnel is housed in temporary structures, built during the war with an anticipated life at the time of construction not in excess of five years. That time has long since passed, and these structures, providing as they do very poor quarters at best, have been maintained as well as possible by the expenditure of sums for repairs out of all proportion to the value of the buildings. While I realize that this condition is general in the Army, the Air Corps, however, is peculiarly placed because, having grown up entirely during the war, it has very little permanent construction work, whereas garrisons built before the war are available to most of the other arms.[24]

Army aviation received an additional boost through the Air Corps Act of 1926. Among other provisions, the law changed the name of the Air Service to the Air Corps, authorized additional men and aircraft, and directed the Chief of the Air Corps to develop a five-year plan for implementing the legislation. Although the new law did not mention new installations, the expansion of Army aviation implied new facilities. As part of the five-year plan, the Chief of the Air Corps proposed further development at 32 fields and construction of two other fields. Although the Air Corps' implementation of the plan fell short of its desires, the years from 1926 to 1932 marked some of the first permanent construction and physical improvements of aviation facilities.[25]

Even with limited funds, Air Corps officers constructed a comfortable, aesthetically pleasing installation. More than 30 years after Randolph Field's completion, Brigadier General Frank Lahm related an anecdote involving a visit by Congressman O. James, chairman of the House Military Affairs Committee.

> While on an inspection trip to Randolph Field, he [Congressman James] noted the presence of an oval pool behind the Officers Mess Building. "Where did that come from?' he asked. "We didn't authorize any expenditures for swimming pools." When he was told that it was not a swimming pool, but an auxiliary fire reservoir, he remarked, "If that's the purpose of it, why the underwater lighting?" It was then explained to him that if a fireman should happen to fall in at night, we wouldn't be able to locate him without the lighting. With tongue in cheek, he then authorized the construction of three "fire reservoirs" provided no other Congressmen were told about it.[26]

General Lahm also related how the constructing quartermaster persuaded local builders to donate labor and materials for the main gate. During a visit to Randolph Field, the chief of the Quartermaster Corps Construction Division remarked "I was sorry I had to turn you down on your request for funds for this entrance, but hell, I knew you would find some way to build it anyway."[27]

As part of the continuing reevaluation of military aviation, the War Department appointed another board in 1933 commonly known as the Drum Board. This board considered the location of air fields in connection with their importance to the defense of the United States, and recommended concentration of air installations within seven areas. These areas were (1) New England, (2) Chesapeake and Mid-Atlantic Region, (3) Caribbean, (4) Great Lakes, (5) Puget Sound area, (6) San Francisco Bay area, and (7) Los Angeles-San Diego area. These locations along the borders of the United States were not coincidental. The stated purpose of these installations was to protect the continental United States against hostile air attacks. The Great Lakes regions probably were included to garner political support, given the extremely low probability of a war with Britain.[28]

The recommendations of the Drum Board were incorporated into the Wilcox Act in 1935. The authors of this law avoided congressional haggling over specific locations by authorizing the War Department to select sites within the seven specified regions. The authors also avoided disagreements over the amount of money required by authorizing "such sums of money as may be necessary." The wording of this law was so broad that it could be used to cover virtually every Air Corps construction project from 1935 to World War II. Some Congressmen even called it the "Mother Hubbard Act" because the Air Corps could continue to use it as desired. Actual construction still depended on specific appropriations from Congress, but the Wilcox Act provided the authorization.[29]

Air Corps experiments in lighter-than-air craft also produced some specialized facilities. During the 1920s, the Air Corps experimented with blimps and airships for reconnaissance, coastal patrol, and aerial photography duties. Lighter-than-air units were stationed at Scott Field, Illinois, and Langley Field. Both fields, therefore, contained the extra-large hangers required for airships. Langley also contained a helium factory until 1929, when the building was remodeled into a stable.[30]

The Air Corps also developed heavy bombers and implemented other technical improvements that required improved runways and support facilities. Thus, the 1930s were characterized by the construction of hard surface runways, landing lights, larger aircraft hangers and maintenance facilities. These changes may not have been as swift as some Air Corps officers hoped, but any military construction was an achievement during the fiscally constrained climate of the 1930s.[31]

Air Corps Training

Missions of Air Corps installations generally paralleled those of the ground portion of the Army. Most bases were homes of flying units (Figure I-11). Others served as Air Corps schools. Special Air Corps depots provided the logistical support for particular aviation requirements.I n 1926, the Air Corps Training Center opened at Brooks Field, Texas, providing a training program for new aviators. Pilots could receive their basic flight training at Brooks or March fields, and then take advanced training at Kelly Field. In 1928, the Air Corps acquired some land outside San Antonio, Texas, to become Randolph Field, the new primary pilot training installation.[32]

Other Air Corps schools offered advanced education and specialized instruction. The Air Corps Tactical School began as an Air Corps Field Officers' School at Langley Field. In 1931, it moved to Maxwell Field in Alabama, where the school benefitted from its proximity to the Infantry School at Ft. Benning. This school taught mid-level officers the doctrine of the ground combat arms, and the Air Corps' concept for employing air power. After World War II, the Tactical School became the Air University.[33]

The Technical School suffered from inadequate facilities at Chanute Field in Rantoul, Illinois. However, efforts to move the school were blocked by Illinois congressmen. Eventually, the War Department established a photography and armament school in Denver, Colorado, now Lowry AFB, and kept the mechanics' school at Chanute Field. In the process, Chanute also received new construction money.[34]

Air Corps Logistical Support

As Army aviation increased in operational autonomy, it also acquired greater control over its logistical support. Some aviation-related depots had existed since World War I, such as the Engine and Repair Depot in Montgomery, Alabama, which later became Maxwell Air Force Base. With the special logistical requirements of aviation, the depot system expanded during the inter-war years. Despite overall reductions after World War I, the Air Corps maintained its separate depot system, and even added another depot at Sacramento, California, now McClellan AFB. Dayton, Ohio, had been important to Air Corps logistics since the creation of Fairfield Depot during World War I. In 1926, the Air Corps established a Materiel Division in McCook Field, also at Dayton. Upon completion of Wright Field in Dayton, the Materiel Division moved to the new field. Today, Wright-Patterson Air Force Base contains both the former Wright Field and the Fairfield Depot.[35]

Navy

The history of the Navy during these years was dominated by international naval disarmament conferences, the growing threat of Japan, and the emergence of aircraft and submarines as formidable new weapons. Each of these trends affected naval installations. Even with the limitations of the naval disarmament conferences and the generally pacifist mood of the inter-war years, the Navy made some progress towards the impending war with Japan. The Navy had refocused its attention on the Pacific Ocean with the improvement of its installations on the West Coast and in Hawaii. Despite the traditional preference for surface warfare, it had incorporated aircraft and submarines into its system, and had improved the capabilities of both weapons. When war returned during the 1940s, these improvements contributed significantly to the American war effort.

Figure I-11. Aviators at Pope Field, adjacent to Ft. Bragg, North Carolina, provided air support to ground troops. The 1934 hangar typifies bowstring truss hangar construction of the time period.

War Plans and the Shift to the Pacific

The destruction of the German Navy during World War I left the world with three credible naval powers: the United States, Great Britain, and Japan. Initially for the United States, this situation was a matter of some concern because Japan and Britain had a treaty of friendship that was not scheduled to expire until 1921. Moreover, the rapid rise of U.S. naval power had caused concern among the British about the loss of their preeminence.[36]

To preclude a naval armament race among the three powers, the United States proposed what was termed the Washington Naval Disarmament Conference of 1921 and 1922. At the conclusion of the conference, the three powers fixed a tonnage ratio in capital ships of 5: 5: 3 for the United States, Britain, and Japan, respectively. As part of the treaty, the United States and Japan agreed not to fortify islands in the western Pacific. Hawaii was not covered in the second part of the agreement, but the Philippines, Guam, and Samoa all were to be left unprotected. A second disarmament conference at London in 1930 reaffirmed the provisions of the Washington Conference, and added a five-year moratorium on capital ship construction.[37]

For the American public, the disarmament conferences could have been viewed as another indication of a peaceful future. Yet the Navy was more concerned about the growing Japanese threat to the Philippines and other possessions in the western Pacific. The prohibition of fortifications meant that these islands probably would be captured early in a war, and the United States would be forced to fight its way across the Pacific. As Japan became increasingly aggressive towards its neighbors, Navy war planners concentrated on the ORANGE scenario, i.e., war against Japan.

The Navy traditionally had concentrated in the Atlantic Ocean, with most of its facilities on the Atlantic or Gulf coasts. The new focus on a war with Japan forced the Navy to shift its forces to the Pacific. In 1922, it divided the fleet into a Battle Fleet stationed in the Pacific, and a Scouting Fleet in the Atlantic. The next problem for the Navy was to find the shore facilities to support a Pacific fleet. Mare Island had been the leading Navy installation on the West Coast since the nineteenth century, but the channel, sufficient for nineteenth-century ships, was too shallow for modern battleships. The Navy thus began an expansion program for its Pacific bases, with the three leading beneficiaries being San Diego, California; Bremerton, Washington; and Pearl Harbor, Hawaii. Improvements began slowly during the 1920s and accelerated during the 1930s.[38]

Navy Department activity in the San Diego area began with a coaling station in 1901, and a communications station in 1906. A training facility and an air station were added during World War I. After the war, these facilities were retained and expanded to augment the Navy's presence in the Pacific. The coaling station was expanded into the Naval Supply Depot, and later the Naval Supply Center, complete with warehouses and piers.

In 1920, the Navy activated a Naval Operating Base at San Diego, and in 1921, it established the Eleventh Naval District Headquarters at San Diego. Until the fleet was moved to Pearl Harbor in 1940, San Diego served as the principal operating base for the Pacific Fleet. The Navy also acquired a marshland area from the city of San Diego that it improved into a destroyer base. Like other Pacific Coast facilities, this destroyer base was improved steadily during the 1920s and 1930s by the addition of marine railways, dry docks, piers, and related facilities.[39]

The deep channel at the Puget Sound Naval Shipyard in Bremerton made it a more suitable site for a yard in the Pacific. Even before World War I, the yard was improved in response to the Japanese threat. During the inter-war years, the yard's importance increased in proportion to the potential for war with Japan. Even with the limited shipbuilding programs resulting from the

disarmament conferences, Puget Sound received its share of projects, including construction of seven destroyers. Among its most significant additions were a huge crane, and a five-acre machine and electrical shop complex, both added during the Franklin Roosevelt administration (Figure I-12).[40]

Since its establishment as a coaling station at the beginning of the twentieth century, Pearl Harbor had been valued as an outpost against Japan. With increasing emphasis on war plan ORANGE during the 1920s and 1930s, the Navy developed Pearl Harbor into a major repair and supply facility by dredging the channel, improving dry docks, creating a fuel oil depot, and otherwise adding to the base. Pearl Harbor also became the home of a submarine base and Navy airfields. In 1940, Roosevelt ordered the Pacific Fleet to remain in Hawaii after the conclusion of its fleet maneuvers. With a surrounding complex of Army coastal artillery, Pearl Harbor was considered safe from the Japanese Navy. The only conceivable threat to the base was a carrier-based air attack, a scenario considered highly unlikely by the leading admirals.[41]

Submarines and Aviation

Aside from the Japanese threat, Navy history during the inter-war years was affected by the improvement of new weapons that changed the nature of naval warfare. The aircraft and submarine had emerged during World War I as valuable new weapons. During the inter-war years, the primitive submarines and aircraft of World War I developed into far more sophisticated and lethal weapons.

Navy leadership believed that the battleship and cruiser would dominate any future wars. Many admirals recognized the full destructive power of aircraft and submarines, but others considered the new weapons primarily valuable for their reconnaissance abilities. Aircraft were described as the "eyes of the fleet." As late as 1940, a Naval War College study pointed out that 1,200 aircraft were needed to carry as much ordnance as one battleship. The authors were less concerned about the ability of a carrier to sink a battleship from a distance. The preponderance of the Navy's attention thus remained on surface warfare.[42]

Great Britain had demonstrated the feasibility of the aircraft carrier with the construction of the world's first carriers during World War I. However, the United States did not construct its first carrier until 1922, after Billy Mitchell had demonstrated the ability of aircraft to sink a battleship in some well-publicized tests off Hampton Roads, Virginia. The first U.S. carrier was a collier that had been converted to a carrier by adding a flight deck on the superstructure and renaming it the *Langley*. In 1927, the Navy converted two cruisers, the *Lexington* and *Saratoga*, into carriers. The first American ship constructed from the keel up as a carrier was commissioned the *Ranger* in 1934.[43]

As naval aviation slowly increased in importance, the number of installations supporting aviation increased proportionally. Pensacola already had become the location for initial flight training of heavier-than-air aviators. Sailors learned aircraft maintenance and associated skills at the Great Lakes Training Station. The Anacostia Naval Air Station conducted testing and experimental work. Norfolk, San Diego, and Pearl Harbor stations were fleet aircraft bases, supporting their respective fleets. A station in the Canal Zone participated in the defense of the Panama Canal.[44]

Naval aviators also experimented with lighter-than-air craft, especially the rigid airships. With their steel frame superstructures, these huge airships could carry crews of up to 75 personnel, and conduct long-range patrols. To accommodate the airships, the Navy established an air station at Lakehurst, New Jersey, as an aerial port for lighter-than-air craft. Lakehurst's

Figure I-12. The 1938 forge shop at Puget Sound Navy Yard is an example of the massive, utilitarian construction built during the Navy's focus on the Pacific theater.

facilities for docking airships resulted in its use for commercial airships, including the *Hindenberg* at the time of its tragic fire. Moffett Field in California provided the lighter-than-air facility for the West Coast (Figure I-13). Although the Navy discontinued rigid airships after a series of crashes, both sites were used for non-rigid blimps through World War II.[45]

Submarines, like aircraft, were welcomed for their reconnaissance capability. Despite the success of German submarines during World War I, their potentially devastating effect on enemy commerce was not fully appreciated. Submarine commanders who attacked a battle fleet during maneuvers were "rated irresponsible and marked down in command ability." Submarine warfare, therefore, remained the domain of specialists.[46]

Despite the lack of priority given to submarines, Navy engineers succeeded in solving a number of technical problems. By the 1930s, the new fleet of submarines had sufficient speed, cruising range, and ammunition load to pose a formidable threat to surface ships. Improved diesel engines and extensive networks of electric batteries enabled the new submarines to keep pace with the surface fleet.[47] Two Navy installations, New London Naval Base and Portsmouth Navy Yard, provided the shore installation support for submarines.

The Navy had acquired the New London facility in 1868, but had left the site practically untouched until 1898, when New London became a minor coaling facility. During World War I, the site became a submarine base and training facility. It continued these functions through the inter-war years, with an added role as an experimental facility for salvage work.[48]

The Portsmouth Yard became the Navy's primary installation for construction of submarines. Although most submarines were built at private shipyards, the Navy maintained its capability for in-house construction of all types of ships as an alternative to contractors. Moreover, the Portsmouth facility enabled the Navy to conduct experiments in submarine design and safety features. After 1919, virtually all submarine designs were completed at the Portsmouth Yard, usually based on specifications developed at the Bureau of Construction and Repair.[49]

Marine Corps

During the inter-war years, the Marine Corps developed into the Fleet Marine Force that operated effectively during World War II and afterwards. Gradually, the Marine Corps discontinued its role as ships guards. Through the 1920s, marines continued occupation duty in foreign nations, most notably Nicaragua and China, yet that role also diminished in time. In later years, the primary mission of the Marine Corps was amphibious operations in support of naval campaigns.

Amphibious Warfare and Marine Corps Aviation

The Marine Corps' new emphasis on amphibious operations developed from war plan ORANGE. Navy planners recognized that Japan could either seize or threaten the Philippines, and that the Navy must fight its way across the Pacific to reach the islands. Japanese bases in Micronesia, including the Marshalls, Caroline, and Marianias islands threatened an American advance. If the Japanese seized American islands, such as Guam or Wake Island, the United States could be deprived of bases in the western Pacific. Marine Corps leaders, particularly its commandants John A. LeJeune and John H. Russell, accepted the new role and directed that the Marine Corps emphasize amphibious operations in support of the Navy. In December 1933, the term Fleet Marine Force was adopted to stress its new mission.

Both the Marine Corps and the Army had participated in amphibious operations since the Revolutionary War. Modern military technology, however, provided new advantages to a defender, making military leaders question whether an opposed landing was feasible. Consequently, the Marine Corps began to restudy the doctrine, equipment, and tactics required to seize an enemy beachhead. Their efforts were aided by a series of exercises in Puerto Rico and Hawaii, in which Marines assaulted a beachhead that was "defended" by either Army or Marine Corps units.

Officers at the Marine Corps School in Quantico produced the Navy Department's first doctrine on amphibious operations. Work on the *Tentative Manual for Landing Operations* had begun in 1931, and the first version was completed by 1934. In this publication, Marine Corps officers identified critical problems of command relationships, gunfire and air support, assault tactics, and logistics. With its subsequent refinements, the *Tentative Manual* became the doctrinal basis for Marine Corps operations in the Pacific during World War II.[50]

Like the other services, the Marine Corps also integrated aviation into its operations. From the beginning, Marine Corps aviators had stressed that the purpose of their efforts was to support Marine Corps ground forces. Marines served in Haiti and Nicaragua, where they supported ground forces through reconnaissance and strafing, marking the first time that the Marine Corps air-ground team functioned in combat. Marine aviators participated in writing the *Tentative Manual*, and delineated the roles for aviation in amphibious operations. The Marine Corps constructed airfields at Parris Island, San Diego, and Quantico. By the beginning of World War II, aviation had become an essential part of Marine Corps operations.[51]

Marine Corps Installations

As part of the Marine Corps' emphasis on functioning as an amphibious force in support of naval campaigns, the Marines maintained their installations at Parris Island, San Diego, and Quantico. Though a large number of Marines remained assigned to Navy installations, on ships, or in foreign nations, the Marine Corps maintained distinct installations, primarily as training facilities.

With the effectiveness of their recruit training in World War I, the Marine Corps continued the practice of indoctrinating recruits at Parris Island, which officially was called the Marine Corps Recruit Depot. The close of the war had left 631 wooden barracks and 13 brick buildings to accommodate the training facility. Although a lack of appropriations limited the physical improvements at the installation, the Marines constructed a causeway to the mainland and made other improvements, including a post exchange.[52]

Quantico became an educational center for the Corps. By 1920, the officer courses were consolidated into the Marine Corps School, which offered a company officer and a field officer course. The Marine Corps Institute, which produced correspondence courses for the service, began during the inter-war years. As noted above, the school devoted an increasing amount of its attention to amphibious warfare, and also wrote amphibious doctrine. The school also included committees to study equipment, such as landing craft, for amphibious operations. The airfield was expanded into the Marine Corps Air Station, Quantico. Until 1940, Quantico also housed the Marine Corps units for the Atlantic area. With all of this activity came an increase in construction, as the Navy Department built new barracks, administrative buildings, support facilities, and a full range of other structures. One of Quantico's more colorful commanders, Brigadier General Smedly T. Butler, had his men build a stadium for football games.[53]

The San Diego base originated from the Marine Corps' need to increase its presence in the Pacific region, as part of the military's shift of focus to the Pacific. The Navy Department

Figure I-13. Moffett Naval Air Station was established in 1931 to provide a West Coast lighter-than-air base. The center hangar was built to house rigid airships, also known as dirigibles.

acquired ground for the Marine Corps Barracks in 1919, and the Marine Corps occupied the site in 1921. Its commander, Brigadier General Joseph Pendelton, insisted on a well-constructed post, with Spanish Colonial architecture. His wishes were followed until construction funding stopped in 1924. At first, the base was primarily a home for Marine Expeditionary Forces, later called Fleet Marine Forces. The Recruit Depot was a tenant activity. In time, the primary function of the base became recruit training, with associated schools added to the facility.[54]

The Marine Corps' focus on amphibious operations during the inter-war years proved to be a critical factor during World War II. With the traditional functions of ships complements and foreign intervention becoming obsolete, the Marines redirected their energies towards a war in the Pacific. Recognizing that any naval campaign depended on the seizure of operating bases, they developed the art of amphibious warfare. They began the period with little training, doctrine, or equipment for modern amphibious warfare. By the opening of World War II, they were capable of retaking the western Pacific from the Japanese.

Although few in numbers, the Marine Corps installations made a critical contribution to this effort by providing the necessary training facilities. Recruits learned their duties at Parris Island or San Diego. The school at Quantico educated the officers and provided the institutional framework for developing new doctrine and equipment.

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POST SCRIPT

In December 1941, the United States entered World War II, and the size of U.S. armed forces increased dramatically. More than 15 million men and women entered the armed forces. The Army, including the Air Corps, alone expanded from a little more than 160,000 to more than 10 million personnel. With the increase in personnel came a corresponding multiplication of the extent of the military's real property. New installations were created and old installations expanded through temporary construction. Existing installations were used to their maximum capacity during World War II.

Even after the war ended, the U.S. military did not return to it pre-war levels. The threat of the Soviet Union and the position of the United States as a global power resulted in an American presence overseas. The military no longer concentrated on the defense of the United States, but sought to protect U.S. security by also defending U.S. allies. Since World War II, the United States has maintained an enlarged peacetime military, with budgets beyond the dreams of earlier military leaders. The United States has operated a far larger complex of installations than was conceivable before 1940.

The older installations serve as reminders of the other functions performed by the military. Nineteenth-century Army forts and Navy yards recall the role of the Army in protecting the frontier and the Navy in defending American commerce. Some of these installations contributed to the modernization of the military during the late nineteenth and early twentieth centuries. Others were used to train personnel for World War I, or to prepare for the Second World War. All of these represent part of the legacy bequeathed by earlier generations of soldiers, sailors, Marines, and airmen.

INTRODUCTION TO PART II - THEME STUDIES

The *National Historic Context for Department of Defense Installations, 1790 - 1940* is a Legacy Program demonstration project designed to assist the Department of Defense (DoD) in executing its responsibilities for cultural resources under the National Historic Preservation Act of 1966, as amended, applying the Secretary of the Interior's Standards for Preservation Planning and the guidelines of the National Register Program. The purpose of the project is to examine the complex historical and architectural relationships among DoD construction on a nationwide basis to provide comparative information on the historic significance of military construction in the contiguous United States between 1790 and 1940.

The National Military Context integrates the three components of an historic context - time period, geographic area, and theme. The overall study is organized into five sections:

Part I - Chronological Overview;
Part II - Theme Studies;
Part III - Property Types;
Part IV - Installation Site Reports; and,
Part V - National Register Nomination Case Studies.

Part II - Themes is presented in the following section and provides an in-depth discussion of six subjects identified in the context as important to the evaluation of DoD historic property:

- Chapter 1: Communications,
- Chapter 2: Education,
- Chapter 3: Medicine,
- Chapter 4: Planning and Architecture,
- Chapter 5: Technology, and
- Chapter 6: Transportation.

Each theme is divided into subtopics of particular importance in military construction.

The *Theme Studies* and *Chronological Overview* are cross-referenced in the accompanying matrix (Table II-1). The matrix provides the reader with a reference tool to identify time periods in *Part I - Chronological Overview* of particular importance to the specific topics explored in greater depth in the theme studies. The matrix included in the introduction to *Part III - Property Types* cross-references the themes with the property types (Table III-1). Each installation site report in *Part IV* lists the themes relevant to that installation. This provides comparative, site-specific examples of installations related to the historical topics explored in the theme studies.

TABLE II-1.

INDEX OF THEMES AND CHRONOLOGICAL OVERVIEW.

CHRONOLOGICAL OVERVIEW.

THEMES		1790 - 1860								1860 - 1890											1890 - 1918																				1918 - 1940									
		Army					Navy and Marine Corps			Army							Navy and Marine Corps				Army								Navy								Marine Corps								Army			Army Air Corps				Navy		Marine Corps	
		Frontier Forts East of the Mississippi	Frontier Forts West of the Mississippi	Coastal Fortifications	Arsenals and Armories	Education and Training	Naval Yards and Stations	Hospitals and the Naval Observatory	Marine Corps	Civil War	Frontier Posts	Coastal Defense	Ordnance Department	Quartermaster Depots	Signal Corps	Education	Results of the Civil War	Beginnings of Naval Modernization	Changing Roles of Shore Installations	Marine Corps	Army Operations	Closing the Frontier and Consolidating Posts	Coastal Defense	Development of Professional Education and Training	Development of Logistical Functions	Wartime Cantonments	Beginnings of Army Aviation	World War I Army Aviation	Steel Ship Construction and Repair	Development of Naval Ordnance	Logistical Support to the Fleet	Officer Education and Recruit Training	Personnel Support	New Technology: Submarines, Aircraft, and Radio	World War I Navy Construction	Ships Complements	Foreign Intervention	Installations and Schools	World War I	War Planning and Institutional Development	Installation Improvement	Training, Coastal Defense, Schools, and Logistics	Towards a Separate Air Force	New Construction of Air Corps Installations	Air Corps Training and Logistical Support	War Plans and the Shift to the Pacific	Submarines and Aviation	Amphibious Warfare and Marine Corps Aviation	Marine Corps Installations
Communications	Early Communications						●																										●														●		
	Military Telegraphy and the Development of the Army Signal Corps									●	●				●																																		
	Navy Wireless Communications during the Twentieth Century																																●																
	The Army Signal Corps during the Twentieth Century																									●	●																	●					
Education	Military Education in the Early Republic					●	●																																										
	Beginnings of Military Professionalism															●			●																																
	Military Education during the Progressive Era and World War I																						●		●						●			●			●	●										
	Military Education between the Wars																																										●		●	●				●
Medicine	Military Medicine in the Early Republic	●	●					●																																									
	Civil War and National Expansion									●	●																																						
	Military Medicine during the Progressive Era																				●			●		●																							
	Military Medicine during the Inter-war Years																																											●		●	●		●		
	Women in Military Medicine									●											●					●																							
Planning and Architecture	Coastal Fortifications			●																																													
	Early Frontier Posts	●	●								●			●																																				
	Industrial Eclecticism: Ordnance Facilities and Shipyards				●		●						●						●	●	●																												
	Consolidation and Modernization: The Trans. from Eclecticism to Beaux Arts																		●			●		●						●	●	●						●										
	World War I: Temporary and Permanent Construction																									●		●						●	●				●									
	Inter-war years: Regional Architecture and Community Planning																																											●		●	●		●
Technology	Weapons and Ammunition				●		●			●			●				●	●						●						●					●								●		●					
	Fortifications			●						●		●										●																				●		●					
	Warships						●												●										●		●			●	●												●	●	
	Military Aircraft																										●	●						●								●			●	●	●		●	●	
Trans-portation	Military Contributions to Transportation Development	●	●				●		●																		●	●	●					●										●					
	Benefits of Transportation Systems to the Military	●	●							●	●										●	●				●										●												

CHAPTER 1
COMMUNICATIONS

Until the Civil War, military communications were relatively simple. Both the Army and Navy relied primarily on messengers or written reports. The Navy employed the European system of signal flags when ships were in visual contact; otherwise, a ship's captain was isolated from his superiors. However, with the arrival of the military telegraph in the Civil War, improved communications allowed commanders to coordinate actions of dispersed units. At the beginning of the twentieth century, the wireless telegraph and radio further revolutionized military communications, providing for communications with ships or units that were in motion.

Early Communications

The practice of using signal flags for communicating between ships began in the British Navy when the Duke of York (later James II) introduced a system of fighting instructions. The system consisted of five flags that could be placed in any one of five positions on a ship, providing 25 different combinations. Its usefulness was aided by the recently invented telescope. The limitations of this system became apparent as admirals unsuccessfully tried to introduce new instructions into the system. During the 1790s, the British Captain Richard Kempenfelt introduced a new system of using flags to represent numbers, thus allowing a virtually limitless combination of signals. That concept became the standard naval communications system during the nineteenth century.[1]

The American Navy generally followed the British lead. During the American Revolution, the Navy used a primitive system of recognition signals. In 1797, Captain Thomas Truxton wrote the first signal book based on the numerary system. Although Truxton's system was not adopted, it was followed by another signal book, known as the "Barron Signal Book," which was used until the War of 1812. Thereafter, the U.S. Navy continued to use variations of signal flags, supplemented by lanterns or gun signals during night or times of poor visibility.[2] Because the system only worked while ships remained in visual contact, a ship's captain virtually was unconstrained once he separated from the remainder of the fleet.

Army experimentation with signal flags began during the 1850s. Albert Myer, a military surgeon, developed the idea of signal flags while serving in the west. He developed a simple semaphore system where varying positions of a signal flag or torch represented letters of the alphabet. His invention was first employed at the beginning of the Civil War by Union soldiers near Ft. Monroe, Virginia. Ironically, the first successful use of a semaphore in battle was at Manassas, by Confederate officers who had learned the system from Myer. Thereafter, both sides used the system during the Civil War, as signalmen would position themselves on housetops, in trees, or other platforms to relay messages. The U.S. Army Signal Service began with this new method of communication, and Myer became the first Chief Signal Officer.[3]

In a related development, the Signal Service also experimented with balloons. The Union forces used tethered balloons to observe movements of enemy forces during battles. These balloons marked the beginning of Signal Service control of aviation, which lasted until the 1920s.

Military Telegraphy and the Development of the Army Signal Corps

The first successful demonstration of the telegraph over a long distance came in 1843, when Samuel F. B. Morse wired his famous message "What hath God wrought?" from Washington

to Baltimore. Although its usefulness was limited to those locations near telegraph lines, it provided for instantaneous communications over vast distances. During the Civil War, the telegraph was used for communications between the important headquarters.

Communications during the Civil War were complicated by bureaucratic battling between the Military Telegraph Service and the Signal Corps. The Telegraph Service consisted of civilian operators working for the government, while the Signal Corps consisted of military personnel under the direction of Colonel Myer. Although Signal Corps personnel lacked training in telegraph operations, they compensated for this deficiency by adopting the Beardslee Sounder. This equipment was simpler to operate than a telegraph, but it also was slower and less reliable. Myer believed that all communications, including the Military Telegraph Service, should be under his control. For political and practical reasons, Secretary of War Edwin Stanton favored separation of the Telegraph Service. During the subsequent battling, Myer was reassigned to the Army of the Mississippi, and did not return to his position as the Chief Signal Officer in Washington until after the Civil War.[4]

Interest in military communications languished during the post-Civil War period. Then in 1870, Congress assigned to the War Department an entirely new mission, that of collecting weather observations and signaling storm warnings across the nation. The War Department brought Myer back to Washington as Chief Signal Officer and assigned him responsibility for the weather service. Myer began to assemble officers and men at Ft. Whipple, Virginia (later renamed Ft. Myer) to teach them both weather observations and telegraphy. By November 1870, he began to collect weather observations from all over the nation to produce the first weather reports.

By instructing all observers to take weather measurements simultaneously, Myer was able to produce the first weather forecasts in the United States. The system was most valued for providing storm warnings to ships. Signal Corps soldiers had laid military telegraph lines along the Atlantic coast to keep in contact with lifesaving stations. The stations would, in turn, display storm warning flags to alert ships in the vicinity.[5]

Although weather forecasting proved to be popular with the civilian population, General Sherman expressed his doubts about the military utility of such ventures. He thought that members of the Signal Corps were "no more soldiers than the men of the Smithsonian Institution. They are making scientific observations of the weather, of great interest to navigators and the country at large. But what does a soldier care about the weather? Whether good or bad, he must take it as it comes." By 1890, responsibility for weather forecasting was transferred to the Department of Agriculture, and the Signal Corps returned to purely military communications.[6]

The efforts of the Signal Corps in the West were of more direct benefit to the Army. During the 1870s and 1880s, the Army connected posts in the western territories with telegraph lines. Forts in regions such as Arizona or the Dakotas were so isolated that contact with commercial telegraph was not feasible; however, the commanders recognized the need for fast, reliable communications. Consequently, the Army began to construct its own telegraph lines, usually with cavalry or infantry soldiers performing the labor under the supervision of Signal Corps officers or non-commissioned officers. The Army recovered part of the costs by selling access to the lines to civilians when there was no military traffic.[7]

With the invention of the telephone by Alexander Graham Bell during the 1870s, the Army became interested in this new device. Ft. Whipple (Ft. Myer) was the site of the first demonstration of a military telephone in 1878. The Army established a phone line between Ft. Whipple (Ft. Myer) and the Signal Office in Washington D.C. By 1892, 59 of 99 garrisons had some type of telephone equipment, either Army-owned or leased.[8]

Yet these new communications facilities could not solve the problems of communicating with forces in the field, who were usually in motion. To remedy the problem of maintaining contact with units on the move, the Signal Corps used a variety of techniques. It improved the "flying telegraph" for rapid installation of temporary lines. Beginning in 1878, the Signal Corps acquired its first homing pigeons.[9]

The heliograph seemed to offer more promise in the southwest. This system operated by using mirrors to flash signals over comparatively long distances. The British Army first developed the heliograph system in India. The U.S. Army in Arizona adopted the heliograph in 1886 and used it to pursue Geronimo.[10]

Navy Wireless Communications during the Twentieth Century

By the close of the nineteenth century, scientists had begun to speculate that light was but one form of electro-magnetic radiation, and that other forms of radiation exhibited many of the characteristics of light. In 1864, James Clerk Maxwell postulated that electro-magnetic energy travels through space in the form of invisible waves, whose behavior was mathematically predictable. The waves traveled at the speed of light, and their length could vary from several meters to less than a millimeter. In 1888, Henrich Rudolph Hertz validated Maxwell's theories by transmitting electro-magnetic waves (or radio waves) across a room.

During the latter 1890s, the Italian inventor Guglielmo Marconi recognized the commercial potential of these theories. He believed that if waves could be transmitted and detected over a sufficient distance, a telegraph system could be constructed without the use of wires. Such a system especially would be useful in areas where telegraph lines were too expensive, or to assist ships at sea. In 1895, Marconi succeeded in transmitting a signal three miles. By 1899, he could transmit telegraphic messages, such as the results of the Americas Cup yacht race, in an early promotional effort.[11]

During the years that followed Marconi's first demonstrations, both continuous improvements in the technology and bitter quarrels among inventors and interested parties characterized the history of wireless communications. Marconi was living in Britain, and because the British government held a monopoly on telegraph service, they resented and resisted Marconi's intrusions into their domain. Other inventors sought to improve Marconi's equipment. Not surprisingly, most inventors stretched their claims for performance of their equipment, discounted the claims of other inventors, and engaged in frequent battles over patent rights.

By 1906, radio engineers were making progress in imposing the human voice or other sounds upon radio waves by changing the shape of the radio waves. Yet the systems were so primitive that they were only of experimental use. Radio did not become practical until after the invention of the "superheterodyne" receiver in World War I.[12]

Promoters of the wireless considered the U.S. Navy one of their most important potential customers, and in later years, the Navy claimed considerable credit for nurturing the infant industry. The Navy commenced testing wireless apparatus in 1899, and began testing equipment of manufacturers by 1902. From 1902 onward, the Navy was a significant market for the new invention.[13]

Yet relations between the Navy and the communications industry prior to World War I was characterized by both antagonisms and cooperation. Despite its admitted usefulness, Navy officers often distrusted both the invention and the inventors. For the first decade of the twentieth century, the Navy came to terms with this new invention slowly and haltingly.

In large part, the Navy's reluctance to accept the wireless resulted from its still limited military usefulness. Radio communications were primitive and unreliable, especially in regions where static electricity affected communications. More serious problems resulted from the vulnerability to enemy action. The first systems broadcast on such a wide spectrum that their signals could be detected easily. From there, the enemy might listen to messages for intelligence value. They also might jam the message with their own signals. As early as 1904, Bradley A. Fiske, one of the Navy's leading advocates of technological advancement, published an article in the *Army and Navy Journal* indicating these limitations of radio.[14]

Other problems resulted from the officers' lack of understanding of radio theory. One flag lieutenant (signal officer) T. P. Magruder, who later was promoted to Rear Admiral, demonstrated a particular lack of comprehension of radio. In 1903 maneuvers, the "blue" force captured the "white" force after a wireless operator failed to jam a critical message. After the maneuvers, the fleet's chief electrician's mate discovered that the wireless operator was confined to the brig, with the following story:

> I was on watch and everything was working fine. I heard a message begin, and the first three letters were G, O, and L, so I knew that it was going to be "gold" and that it was from the other side. I reached for the key, but the Flag Lieutenant [Lieut. Magruder], who was with me said, "No don't do that I want to get the entire message." When the message was ended the Lieutenant said "Make interference," and I said "Sir it's no use now. The message has gone out with a speed of 186,000 miles a second and we can't catch up with it." So here I am on bread and water.

Shortly after that incident, Lieutenant Magruder ordered the wiring on the antenna rearranged to make it more symmetrical with the ship's rigging. When advised that his changes would make the wireless nearly useless, he replied that "he didn't give a damn for the wireless...but he did give a damn about the appearance of the ship."[15]

Another reason for the Navy's early resistance to wireless communications came from its infringement on the traditional prerogatives of ships' captains. With the visual communications of the nineteenth century, Navy officers necessarily were allowed considerable independence, in diplomatic as well as naval affairs. However, better communications threatened to restrict this independence. Therefore, Navy officers tended to disconnect wireless sets, or to display little interest in correcting the problems of radio communication.[16]

The early wireless companies complained that the Navy Department imposed unreasonable contract requirements or infringed on their patent rights. For example, if a company wanted one of its own engineers to be present at a product test, it was done at the company's expense. Upon signing a contract, the wireless company was required to post bonds that their product would perform as advertised, even when the contract required untested technology. In 1905, the Navy adopted an "electrolytic detector" developed by Reginald Fessenden, but considered his prices to be excessive. They turned to other manufacturers for the same device that Fessenden had patented. When Fessenden complained about this patent infringement, the Secretary of the Navy informed him that his prices "relieved [the Department] of any moral obligation" to honor his patents.[17] Patent litigation was so common among radio developers that resolving conflicting claims proved exceedingly difficult.

Nonetheless, the technology of radio communications continued to improve, and the use of radio communication within the Navy expanded. When the "Great White Fleet" set sail around the world in 1907, its ships were equipped with radio telephones. Unfortunately, these sets were designed hastily and of such poor quality that they were disassembled and stowed as soon as the

fleet set sail. This experience caused the Navy to develop its own radio research laboratory in 1908, and to install a transmitting station at Arlington, Virginia, on land acquired from the War Department at Ft. Myer. During these years, the Navy built other shore stations to reach its ships at sea; for example, the Puget Sound Radio Station was built at this time. These stations also transmitted messages from commercial ships when not performing government business. Although the Navy may not have been as enthusiastic about radio as its developers might have wished, it was one of the few agencies that provided any support to radio.[18]

By the second decade of the twentieth century, radio communications within the Navy steadily improved. Part of the credit goes to S. C. Hooper, who became the communications officer of the Atlantic fleet in 1912. Hooper succeeded in imposing discipline and standard procedures on radio operators, who previously operated without supervision from indifferent officers. He then instituted competitions among ships for efficient communications, and generally improved the morale and performance of radio operators. As radio communication became more reliable, it received more support from senior officers. In 1913, the commander of the Atlantic Fleet held maneuvers relying entirely on radio signals, with visual signals to be used only in an emergency.

In 1914, an incident involving U.S. sailors escalated into a major diplomatic crisis resulting in the U.S. occupation of Veracruz and nearly causing a war with Mexico. The occasion provided the first genuine test of modern Navy communications, and demonstrated the strengths and weaknesses of Navy radio. Because the ships' transmitters could not reach as far as the Key West communications station, the Navy stationed a ship off the Mexican port of Tampico to serve as a relay station. Despite some notable lapses in communications security, training programs instituted by Hooper proved their value. American operators could transmit messages much faster than their European counterparts in the vicinity. Because of the radio communications, the admiral on the scene could maintain contact with Washington.[19]

By the second decade of the century, wireless communication had proven itself to the Navy. Beginning in 1915, the Navy began to construct high powered receivers along the Atlantic and Pacific coasts, and to work with the War Department to build receivers in Panama. Radio stations with these new high powered receivers were built at Chollas Heights in San Diego and improved at Puget Sound in Bremerton. Before the beginning of the war in Europe, the Navy built a Radio Test Shop at the Washington Navy Yard, which expanded into the Naval Research Laboratory at Anacostia (Bellevue) in 1923. The Navy assisted in improving vacuum tubes and other radio components that made voice transmissions possible.[20]

When the United States entered World War I, the Navy Department assumed responsibility for all wireless stations in the United States. These stations were used to broadcast orders to the fleet. The Navy activated hundreds of personnel in a Communications Reserve to meet the requirements for trained operators, but even this number was insufficient. Schools at Harvard University and Mare Island trained thousands of sailors as radiomen. The Navy also developed procedures for assigning frequencies within its fleet. World War I also marked the beginning of electronic warfare by the allies. The British learned to track enemy submarines using deciphered German codes. The British also advised the U.S. Navy of the inadequacy of its communications security, and of methods to improve its codes. When President Wilson traveled to France after the war, his ship's communications equipment allowed him to maintain contact with Washington. Electronic communications were now recognized as a vital portion of any military effort.[21]

The Army Signal Corps during the Twentieth Century

Unlike the Navy, the Army frequently had the option of choosing between radio or wire for tactical communications. Although radio (both radio telegraph and radio telephone) offered the advantage of mobility and flexibility, wire communications were more reliable, and less vulnerable to enemy eavesdropping. The Signal Corps, therefore, developed both methods during the twentieth century.

Signal Corps units had deployed to Cuba with the American forces in the Spanish-American War, and made some important contributions to the campaign. They succeeded in laying wire through the dense jungle, despite the tendency of American soldiers to cut the wires and use them as clothes lines. Because of the Signal Corps' efforts, the commanding general of the forces in Cuba maintained contact with the War Department in Washington. One of the more unusual efforts was the use of a field telephone to direct Navy artillery. Observers on a hill phoned information of Navy artillery to a signal post near the shore, who used signal flags to communicate with the ships.[22]

The Signal Corps began to experiment with wireless telegraph in 1906 (Figure II-1). It developed a set that could be carried by three mules. By 1908, the Army tested its wireless equipment in Cuba and the Philippines. From 1914 to 1917, however, the European armies took the lead in developing radio communications, and the British had a practical field wireless by 1918. When the United States entered World War I, Army radio had not yet demonstrated its military usefulness. Equipment was too heavy or too delicate for use in a tactical situation. What radio equipment that the United States did produce arrived too late for use in the war. In the words of an official Army history, "the War Department in Washington had no radio contact with its commanders in the field, and these commanders had no very dependable wireless systems among themselves. Radio carried little of the war's communications load."[23]

The backbone of Army signal work remained wire, both telephone and telegraph. Fortunately, the comparatively slow pace of the offensives allowed the Signal Corps to provide adequate wire communications from the regimental level upwards. In the Meuse-Argonne offensive, the U.S. Army used 2,500 miles of wire per week. In the rear areas, Signal Corps construction crews established multiple telegraph equipment to connect the major headquarters at Tours, Chaumont, Paris, and London, and also to establish service with the United States. To manage the switch boards that suddenly accompanied the Army, the Signal Corps brought American women to France as switchboard operators, where they distinguished themselves for their efficient work, even when threatened by enemy fire.[24]

To train the communications specialists required by the war, the Army opened Camp Alfred Vail near Monmouth, New Jersey. The Signal Corps previously had operated schools at Ft. Myer and Ft. Leavenworth, but these posts could not handle the wartime requirements. After the war, the Signal Corps decided that the New Jersey location offered some unusual advantages as a permanent home for the Signal School. It was close to electronics manufacturers in New York City, which allowed student officers to visit factories. Moreover, the installation had sufficient space, both on post and off-post, for students to practice laying miles of communications wire. In 1925, the camp was converted to a permanent post for the home of the Signal School and renamed Ft. Monmouth.[25]

During the war, the Signal Corps also improved its communications research programs, especially with regard to radio technology. In April 1918, the Radio Laboratory at Camp Alfred Vail opened, which performed experimental work in conjunction with U. S. industries. The Signal Corps also operated a special wartime laboratory in Paris. One of the most important Signal Corps contributions to radio was the superheterodyne, developed by Edwin Armstrong, then a

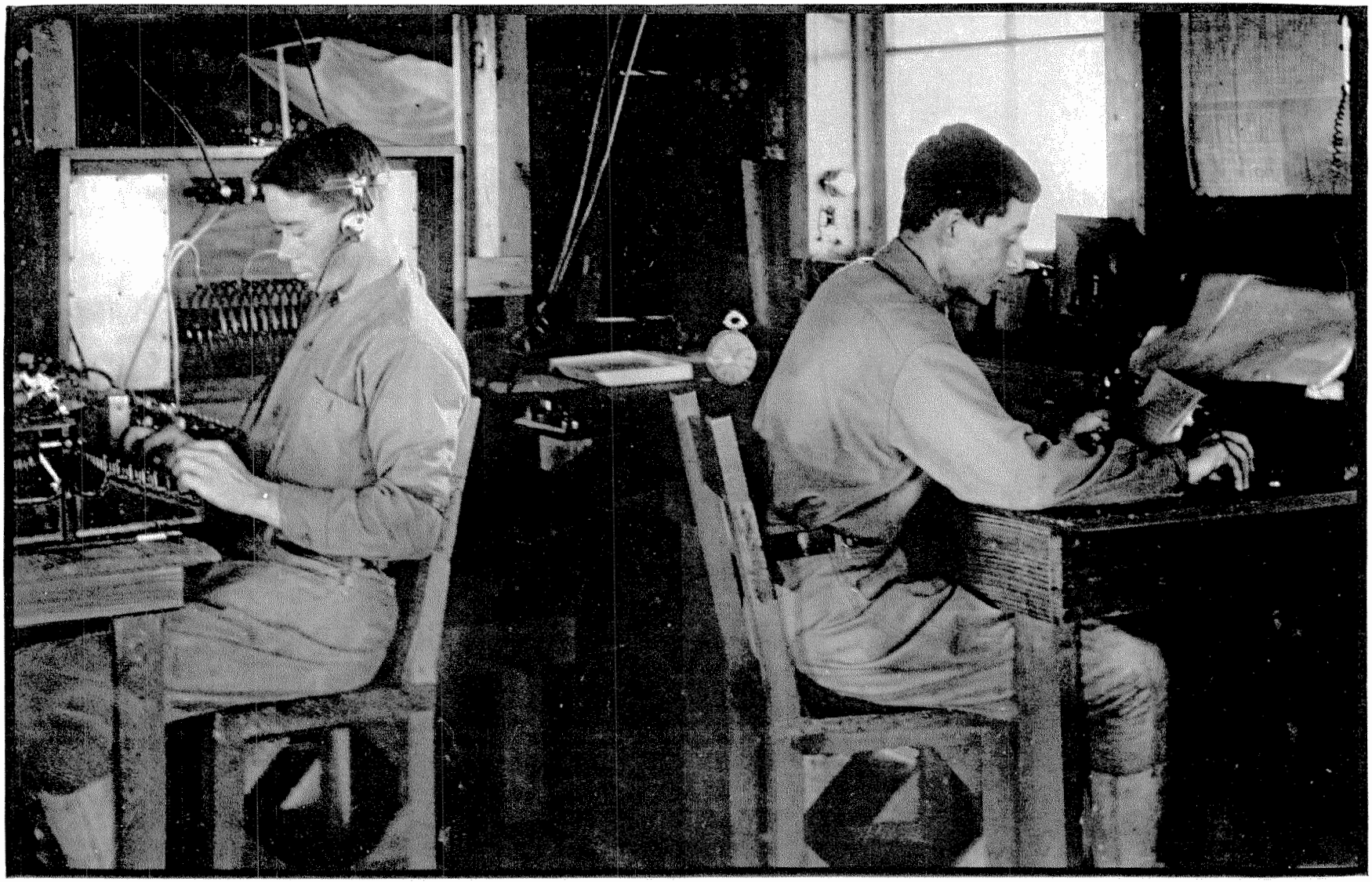

Figure II-1. By the beginning of the twentieth century, the military services were learning the value of wireless communications. Shown here are wireless operators at Camp Columbia, Cuba in 1906. (Courtesy of the Military History Institute)

Signal Corps officer. It allowed the signals from higher frequency radio waves to be transferred to lower frequencies, within an audible range. Although the superheterodyne was developed too late for use in the war, it became a crucial component of commercial radio.[26]

During the inter-war years, the Signal Corps struggled with the same fiscal restraints that handicapped the rest of the Army. Now that radio had proven to be a commercial success, improvements in the technology came rapidly, but the Army could afford only limited purchases of new equipment. Even though it still considered wire to be the backbone of its communications systems, the Army maintained obsolete field phones that became increasingly unreliable as time passed.[27]

One of the challenges facing the Signal Corps during the inter-war years was the need for aircraft radio communications. During World War I, Army aviation ceased to be part of the Signal Corps, and became the Air Service, then the Air Corps after 1926. With the separation from the Signal Corps, the Air Service received responsibility for installing, maintaining, and operating the radios for its aircraft and installations. Yet the Signal Corps still retained responsibility for developing suitable radios. Aircraft radios presented some special problems because they needed to be light enough to be carried aboard a small plane, yet rugged enough to withstand the sudden movements of an airplane. The ignition system could create electronic "noise" that interfered with the radio, and aircraft needed suitable antennae.[28]

The Signal Corps had been experimenting with air-ground communications since World War I, and the first radios were installed in airplanes in 1918. Such equipment was still experimental. Into the early 1920s, pilots used expedient methods of communicating, such as dropping notes from aircraft, or displaying pre-arranged signals on the ground. As the Signal Corps developed its first "130 series," radios for aircraft became a real possibility. Even so, their performance in relation to their weight made them a disappointing product, especially for small pursuit planes. In 1931, the Army finally developed a radio that only weighed 43 pounds and met the Air Corps performance requirements.[29]

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27. Wood, *History of Tactical Communication Techniques*, 200.

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CHAPTER 2
EDUCATION

In today's military, a continuing professional education is an integral part of the career development of every officer and enlisted member. Yet this extensive education system was not always in existence. During the first half of the nineteenth century, military education largely consisted of initial entry training, and even that was often haphazard. The system of education evolved through the second half of the nineteenth century, as part of the increased sophistication of the military, and in response to the growing technical requirements of the Army and Navy. Buildings, landscapes, and entire installations related to military education reflect the contributions of military school systems to the histories of the services and growing professionalism of the military.

Military Education in the Early Republic, 1790-1860

The oldest military education institution was the United States Military Academy (West Point), founded in 1802. Although officers could be commissioned from the ranks or from civilian life, the academy remained a preferred method of obtaining a commission. The curriculum at the Military Academy stressed engineering, although cadets also studied military science and liberal arts. During the early nineteenth century, the U.S. Military Academy and Rennselaer Polytechnic Institute in Troy, New York, established in 1824, were the only major American educational institutions devoted to engineering and scientific training.[1]

Upon leaving West Point, cavalry and infantry officers were expected to learn their duties on the job. The Army had one specialized service school: the Artillery School of Practice at Ft. Monroe, where artillery units received training in artillery, arsenal construction, gunnery practice, and laboratory work. No formal system for preparing officers to accept greater responsibilities as they advanced in rank was established.

During the early nineteenth century, prospective Navy officers learned their profession by serving on warships as midshipmen. Critics of the system advocated a shore-based school, similar to the Military Academy, but they were unsuccessful until 1845. In that year, Secretary of the Navy George Bancroft obtained a surplus Army fort on the Severn River near Annapolis, Maryland, which became the Naval School. It combined academic instruction with required cruises aboard warships to train midshipmen. In 1850, the name was changed to the Naval Academy, and the midshipmen were organized into a battalion for military drill. The curriculum included arts, sciences, technical instruction, and training cruises. This combination has remained in effect. Like the Army, the antebellum Navy did not provide for a continuation of the officers' education past their commissioning. They were expected to learn their jobs at sea. Further theoretical instruction was not considered necessary.

For both services, enlisted education consisted of limited initial training. Upon enlistment, soldiers were assigned to one of three recruit depots: Carlisle Barracks for cavalry, and Governors Island, New York, or Newport Barracks, Kentucky, for infantry or artillery. There, they were drilled until a levy for recruits arrived, and they would be assigned to a unit. The length of time and degree of instruction at a recruit depot varied, and no prescribed course of instruction was followed. Sailors normally were assigned to a "receiving ship," located at a Navy yard. The receiving ship was a vessel permanently anchored at the yard, and used as quarters for transient personnel. There, the sailors might receive some elementary instruction, until they could be assigned to a regular warship.

Beginnings of Military Professionalism 1860-1890

After the Civil War, the primitive education system of the antebellum period slowly evolved into a more sophisticated system. Though the service academies still continued to train new officers, the services also introduced programs beyond the academies to expand the education of their officers. These programs included both specialized training and a broader study of military or naval arts. A general lack of interest in both the Army and Navy during the immediate post-Civil War years hindered any professional development. The Army was scattered in isolated frontier posts, and the Navy maintained a fleet of aging wooden ships. Under these circumstances, both services paid little attention to education until the early 1880s.

During the 1880s, the foundations of a military school system appeared within the context of an awareness that the Army or Navy service constituted a distinct profession. During this period, Army and Navy officers began to articulate a distinct professional ethos. They asserted that war was a specialized science, and that the purpose of the Army or Navy was to fight wars. Consequently, a professional officer should devote himself not only to the routine aspects of warfare, but to the larger principles, as well. Officers also were to refrain from political activities, allowing them to perform their specialized duties under any administration. Three leading proponents of the principles of military professionalism were General William T. Sherman and Colonel Emory Upton from the Army, and Admiral Stephen Luce from the Navy.[2]

American officers, especially Army officers, borrowed considerably from the Prussian military. In 1870, the Germans defeated France in the Franco-Prussian War. Thereafter, Americans traveled to Berlin to observe the German military. The works of Prussian war theorist, Baron Karl Von Clausewitz, became standard reading for American military men. One of the most influential Army reformers, Emory Upton, praised the German model in his book, *The Armies of Asia and Europe.*

Other evidence of a growing professional awareness included the appearance of associations and journals. Navy officers organized the United States Naval Institute, whose *Proceedings* served as a model professional journal. The Military Service Institution of the United States also promoted a professional awareness among officers. Other professional journals, including *The Journal of the United States Artillery*, the *Infantry Journal*, and the *Cavalry Journal*, provided a forum for discussing military issues. Although the *Army and Navy Journal* was less interested in the theoretical aspects of war, it also served to promote common professional bonds.[3]

The growth in professional awareness of the post-Civil War years included an interest in post-graduate education. Part of this interest arose from the German model of a school for advanced military science, or *Kriegsakademie*. The Army's Commanding General, William T. Sherman, proved to be especially sympathetic to professional education. Before he re-entered the service during the Civil War, Sherman had been a college president. This commitment to education was reflected by some of his actions as Commanding General.[4]

In 1881, Sherman instituted the School of Application for Infantry and Cavalry at Ft. Leavenworth, Kansas. At first, this school trained lieutenants in their duties, and included map reading, trigonometry, and grammar in the curriculum. By the 1890s, however, the school developed into one of the most important educational institutions within the Army.[5]

Leavenworth was not the only Army school to appear during these years. The Artillery School at Ft. Monroe was revived in 1868, allowing for advanced instruction in the special skills required of an artillery officer. In the late 1860s, a group of officers from the Corps of Engineers instituted the Essayons Club at Willets Point, New York (now Ft. Totten) to perpetuate a

knowledge of military engineering. These efforts grew into instruction in submarine mining in 1872, and the Engineer School of Application in 1875. Other specialized schools soon followed. An 1887 act of Congress authorized a Cavalry and Light Artillery School, although it was not established at Ft. Riley, Kansas until 1892. At first, this school trained entire units, rather than individual soldiers.[6]

Like the Army, the Navy suffered through a period of professional doldrums during the 1870s. Its fleet consisted of aging wooden vessels, and its officers received little advanced education after commissioning. In 1875, the Navy established a Torpedo School at Newport, Rhode Island, to acquaint some officers with underwater mines.[7] Yet there was little interest in advanced study of the art of warfare.

The Navy's leading advocate of a new professionalism was Rear Admiral Stephen Luce. According to Luce, a formative experience in his life came during the Civil War. As a Lieutenant Commander, he was sent to General Sherman's headquarters in 1865 to coordinate Army and Navy movements. Luce later recalled the episode:

> After hearing General Sherman's clear exposition of the military situation the scales seem to have fallen from my eyes. "Here," I said to myself, "is a soldier who knows his business!" It dawned upon me that there were certain fundamental principles underlying military operations which it were well to look into; principles of general application, whether the operations were conducted on land or at sea.[8]

Later in his career, Luce had the opportunity to act on the insights that he gained. He persuaded the Navy Department to establish a Naval War College at the site of the Torpedo School in Newport, Rhode Island, to educate Navy and Marine Corps officers. He also persuaded the Secretary of the Navy to appoint him as the first president of the Naval War College. Traditionalist Navy officers still could not understand the utility of a school, when officers could learn their jobs at sea. One admiral is alleged to have complained, "Teach the art of war! Well, I'll be damned! You have [James Fennimore] Cooper's *Naval History*, and [Foxhall A.] Parker's *Fleet Tactics*; what more do you want?"[9]

The survival of the school was due largely to the selection of some unusually talented faculty members. For an historian, Luce selected Captain Alfred Thayer Mahan, author of a book on the War of 1812, who later achieved renown with his writings on the importance of sea power. To teach military science, Luce persuaded the Army to assign one of its brightest lieutenants, Tasker H. Bliss, who later became Chief of Staff and an advocate of the Army War College. William McCarty Little, a retired Navy officer living in Newport, also joined the faculty. Little introduced the idea of war gaming as a means of instruction and strategic planning.[10]

Although officer education began to develop into its present form during these years, enlisted education grew very slowly. Both services provided only minimal training for new recruits. After this minimal training, advanced schooling was confined to those enlisted personnel with special skills.

Army recruits still received their initial training at either Governor's Island (Ft. Jay), Carlisle Barracks, or Newport Barracks. The Artillery School at Ft. Monroe continued to train entire units, which included enlisted men. In 1869, the Army opened a Signal School at Ft. Whipple (later Ft. Myer), Virginia, where selected soldiers studied telegraphy and weather forecasting.[11]

In 1883, the Navy began a training squadron at Newport. Boys between the ages of 16 and 18 were enlisted as apprentices and assigned to the training squadron. They received

elementary instruction on the *New Hampshire*, an aging ship-of-the-line that was anchored permanently in the harbor. From there, the young men embarked on a six-month cruise aboard one of the sailing vessels assigned to the training squadron. The emphasis was on a sailing navy, not on the growing technical requirements of a modern navy. Even such respected leaders as Admiral Luce feared that an emphasis on machinery would produce a force of deck hands instead of sailors.[12] More technical education began in the Washington Navy Yard with an ordnance course for career enlisted personnel, and at Newport, with a course in torpedo warfare. Enrollment for these schools was small. In 1890, only 25 men attended the Washington Navy Yard course and 27 attended the Torpedo Station course.[13]

Within the post-Civil War era, both services laid the foundations for the impressive educational system that emerged at the beginning of the twentieth century. The critical change came as military personnel began to view their work as a profession, not merely as a job. With that change came a belief that military service required a special body of knowledge. To develop that knowledge, both the War and Navy Departments instituted the first advanced schools that continued to grow in subsequent years.

Military Education during the Progressive Era and World War I 1890-1918

From 1890 to 1918, the trends in military education and training established during the previous years continued at an accelerated pace. National efforts to define professions, systematize organizations, and embrace technology were manifested in the military's educational programs. The senior service schools at Leavenworth and Newport grew in importance, while other programs for junior officers and enlisted personnel were added to the system. The new technological sophistication of all the services produced new schools, especially with regard to modern warships and military aviation. With the arrival of World War I, the services' educational requirements multiplied, as the military inducted millions of new soldiers, sailors, and marines. The dynamic evolution of a professional military education system helped to transform a nineteenth-century frontier constabulary and navy of aging sailing ships into a modern force with the theoretical knowledge and technical expertise to support the nation's expanding world role.

The Army began this era with the Leavenworth schools still at the apex of its educational system. Through a series of name changes and alterations in curriculum, the school at Leavenworth developed into its present role, a school for educating field-grade officers in commanding larger formations (Figure II-2). One of the most important developments came with the assignment of Captain Arthur L. Wagner to the faculty. Wagner helped expand the curriculum to include more military history and large-unit tactics. He also helped introduce the war game, or *Kriegspiel*, into the curriculum, along with the assignment of map problems to the students.[14]

With the demands of the Spanish-American War and the Philippine Insurrection, instruction at Leavenworth stopped until the fall of 1902. When the school reopened, it became even more of a graduate school. Instruction focused on tactical exercises, so that students could practice making decisions and communicate those decisions in written orders. In 1905, the school announced that it would no longer admit lieutenants, but would accept senior captains and majors. With America's entry into World War I, the value of a Leavenworth education became apparent, as its graduates demonstrated a grasp of the essential problems of commanding division-size formations.

The Army added an Army War College at the beginning of the twentieth century at Washington Barracks (later renamed Ft. McNair), Washington D.C. This school began under the direction of Secretary of War Elihu Root as an institution for studying war at the strategic level; i.e., at a level that involved all the national resources and national policy. The college originally was

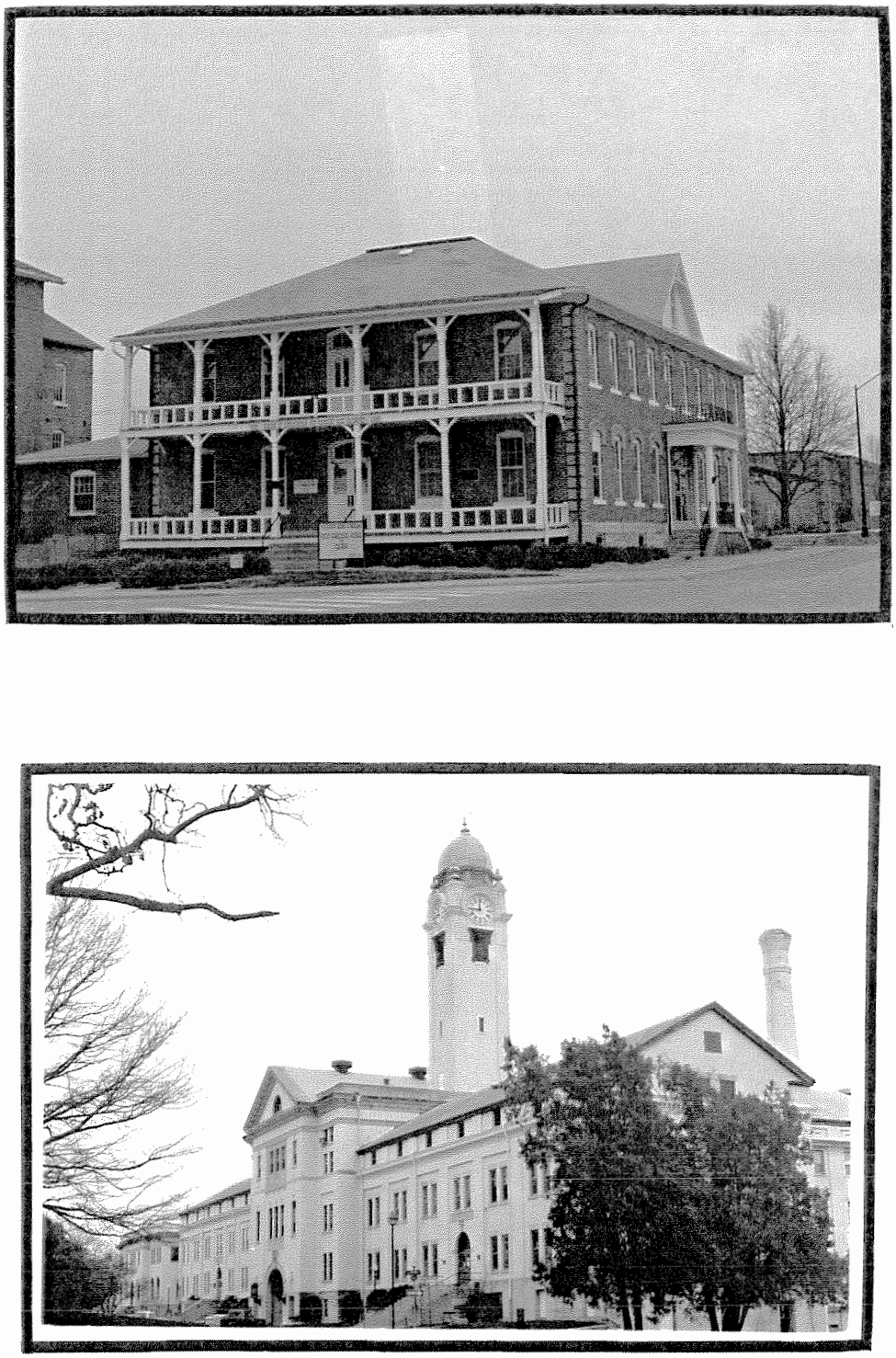

Figure II-2. The contrast between the buildings housing the 1880s School of Application, *above*, and the 1907 General Services School, *below*, at Ft. Leavenworth represents the increased size, prominence, and sophistication of the military education system during the Progressive era.

intended to be an institution where senior officers could improve their professional abilities by studying specific national problems. The methods of instruction combined lectures with practical exercises. For example, students might study the battle of Antietam and write operations orders for either side, using contemporary doctrine. During the first decade of the twentieth century, the War College worked in harmony with the newly-created Army staff to develop contingency plans.[15]

The Army also expanded its officer education system to instruct junior officers in the requirements of their respective branches. Each post was required to operate a post school where the post commander supervised instruction of the junior officers. In 1908, the Cavalry and Light Artillery School at Ft. Riley became the Mounted Service School, as the predecessor to the Cavalry School.[16] The Corps of Engineers and the Medical Department also maintained their own branch schools in Washington. The Medical Department also maintained a Medical Field Service School, which taught the essential points of military affairs to medical personnel.[17] The Engineer School was transferred in 1901 from New York to Washington Barracks (later renamed Ft. McNair). The Artillery School at Ft. Monroe remained active, emphasizing coastal artillery techniques. In 1907, the field artillery was officially separated from the coastal artillery, and Ft. Sill became the home of the School of Fire for Field Artillery. A School of Musketry, the precursor of the modern Infantry School, was established at Ft. Sill in 1907.[18] In 1903, the Ordnance Department opened a training program at Sandy Hook, directed towards officers entering the Ordnance Department.[19] Fort Totten was home to the Submarine Defense School.[20]

Within the Navy, the Naval War College at Newport continued to offer advanced education to Navy and Marine Corps officers. Its reputation and position within the Navy now rested securely on Alfred Thayer Mahan's reputation as a naval historian and theorist. The Navy also expanded its officer education program by opening a post-graduate school at the Naval Academy in Annapolis and assigning selected officers to civilian graduate engineering schools.

During these years, the importance of well-trained, professional, enlisted personnel became increasingly apparent to the Army, Navy, and Marine Corps. Consequently, all the services expanded their programs for enlisted education, both initial entry training and continued professional development. The changes were most noticeable in the technical fields and during World War I.

As the United States entered World War I, the requirements for training new soldiers increased enormously. In 1916, the Army's total strength was 108,399; that number increased to 421,467 by 1917, and 2,395,742 by 1918. To train these new soldiers, the War Department erected large new installations, many of which rank among today's principal Army posts. For the purposes of this report, the World War I installations can be divided into National Guard Cantonments, National Army Cantonments, and other camps.

Both the National Guard and National Army cantonments were designed to hold large units while they trained to move overseas. During the course of the war, the Army constructed 16 cantonments of each type. By any standards, these were impressive projects; the largest cantonments could shelter approximately 40,000 men. The National Guard Cantonments were intended only to shelter National Guard units until they could be prepared for overseas movement. Because they were intended for short-duration use, they were constructed as rapidly as possible. Soldiers were sheltered in tents, although the Army provided limited wooden buildings and the necessary utilities. National Army Cantonments consisted of temporary wooden buildings, quickly constructed, but slightly more substantial than the National Guard installations.

In addition to the camps for line units, the War Department also constructed facilities to train soldiers in the technical branches. The Signal Department concluded that it required a

training site near the major electronics manufacturers, and with sufficient real estate for students to practice communicating over a distance. Consequently, it established Camp Alfred Vail near Monmouth, New Jersey, later renamed Ft. Monmouth. Because of the amount of available land near Fayetteville, North Carolina, the Army placed a field artillery range at Camp Bragg. Recognizing a greater need for training of infantry soldiers, the Army expanded the Infantry School of Arms and moved it from Ft. Sill to Camp Benning, near Columbus, Georgia. The Quartermaster Corps trained its soldiers at Camp Joseph F. Johnston, near Jacksonville, Florida, and at Camp Montgomery Meigs, in Washington, D.C. Camp Humphreys (later Ft. Belvoir), located south of Alexandria, Virginia, became an engineer school; while Camp Eustis, at Williamsburg, Virginia, became a coastal artillery school.[21]

For the Navy, the need for professional education of enlisted personnel had become apparent by the beginning of the century. During the Progressive Era, the Navy was rapidly converting to a force that consisted of comparatively modern steel battleships. Such new ships required personnel who could tend the complicated machinery, not men who could manhandle the sails. Yet until 1904, the Navy instructed its new recruits at the training squadron in Newport. Their first experience with the sea came on training ships that operated by sail power.

In 1904, the Navy finally recognized that sailing ships could not train new recruits in the technically complex duties of the modern Navy. Consequently, it abolished the Training Squadron and established three training stations at Newport, Norfolk, and San Francisco. In 1905, it opened its new facility north of Chicago, which became the Great Lakes Naval Training Station. Henceforth, recruits received four months training on shore, and then joined the fleet. With minor variations, this system has remained until the present time.[22]

The Navy also increased the number of its technical schools to a level appropriate for a modern Navy. By 1915, these schools included two electric schools, a machinist school, a torpedo school, a coppersmith school, a fuel-oil school, an artificer school, two yeoman schools, two commissary schools, two musician schools, and a mess attendant school. These schools were located at the Norfolk, Philadelphia, New York, Charleston, and San Francisco naval yards.[23]

As the Navy entered World War I, its training system was sound enough to meet the wartime needs of the service. The bulk of the new recruits were trained at the four existing training stations, which were expanded by the addition of temporary facilities. The Navy acquired a few temporary camps, such as Pelham Bay, New York, and Bumpkin Island (near Boston), but generally preferred to use its existing facilities. The new camps were either wooden structures or tents with water, sewage, and other utilities. A few contracted civilian colleges and universities for special purpose training completed its wartime training functions.[24]

The increased sophistication of the Navy during World War I also required numerous special schools. Great Lakes Training Station, alone, incorporated programs to teach coxswains, quartermasters, gunners' mates, radio operators, artificers, signalmen, hospital corpsmen, machinists' mates, and armorers their duties. Great Lakes also implemented officer schools, to commission new ensigns in the Navy Reserve, as well as petty officer schools. The commandant, Captain William Moffett, had an interest in aviation that helped to place an airplane mechanics school at Great Lakes.[25]

During this period, the Marine Corps also began to develop its own school system. Throughout the nineteenth century, the Marine Corps had remained a small organization, serving principally to protect Navy yards and to serve on warships. Marine Corps officers in some cases could attend Navy or Army schools, but the Marine Corps operated no specialized schools or training facilities. The first Marine Corps school was a School of Application established at the

Marine Corps Headquarters in Washington, D.C., towards the close of the nineteenth century. This school was followed by the creation of a Marine Officers' School at the Navy station in Port Royal, South Carolina. Other Marine Corps schools included the Advanced Base School in Philadelphia, a Field Artillery School in Annapolis, and a Machine Gun School in Pensacola.[26]

With World War I, came a need for the Marines to train thousands of new recruits. For this purpose, it acquired use of the abandoned Navy installation at Port Royal, South Carolina, which it renamed Parris Island. Here the Marines started a basic training program that achieved widespread renown for its extremely rigorous standards. In Quantico, Virginia, the Marines acquired another base that was used as a staging area, and as an officers' school.[27]

The appearance of military aviation in 1908 created greater education requirements than most other technological developments. The most obvious training need was to teach pilots how to fly, thus necessitating installations with landing fields. The military also needed to teach mechanics and other aviation support personnel their duties.

Army aviation consisted of only a few airplanes and pilots, until World War I. Under these conditions, a small landing field in College Park, Maryland proved adequate for Army pilot training until 1912, when the flight school was moved to San Diego. Upon the U.S. entry into World War I, however, the Army suddenly required thousands of new pilots. To meet the demands, the War Department constructed a variety of new flying fields, many of which later became Air Force bases. The Army established a mechanics school by leasing the Dunwoody Institute, a Minneapolis private school.

The Navy Department operated a small flight school at Annapolis for Navy and Marine Corps pilots until 1914. In that year, it converted the dormant Pensacola Navy Yard to its principal aviation training facility. Pensacola also taught some mechanics, although other installations, such as Great Lakes, also conducted courses for mechanics.

Thus, by the close of the Progressive Era, the military education systems that had been inaugurated prior to 1890 began to reach their potential. The senior service schools, which consisted of the Navy and Army War Colleges plus the Leavenworth schools, now fulfilled a recognized function of teaching higher levels of military and naval science. The services instituted schools to provide specialized education to junior officers. Enlisted education systems grew in proportion to the technological changes adopted by the modernizing Army and Navy. As leaders of the services realized the importance of aviation, they developed training programs for pilots and mechanics.

Military Education Between the Wars 1919-1940

Between the two world wars, the military education institutions matured into the system that produced leaders for World War II. Although all services experienced severe budget constraints during this time, their leaders came to recognize the principle that a sound education system could compensate for the lack of funding.

The Army divided its education institutions into two categories; Special Service Schools focused on branch-related instruction, and General Service Schools offering advanced instruction in combined subjects. In September 1919, the War Department formally established a system of branch schools for each arm under General Orders 112.[28] The number of special schools was expanded to 31 such schools, that taught both officers and enlisted personnel in the specific requirements of their branch; i.e., infantry, cavalry, ordnance, etc. In theory, each officer was expected to attend his branch school within four years of being commissioned. In practice,

however, housing shortages prevented implementation of this policy. Even as late as 1929, the Army did not assign new infantry lieutenants to Ft. Benning because suitable quarters were not available.[29]

For field grade officers, the Army expanded its system of advanced schools to three institutions: the Command and General Staff College at Fort Leavenworth, the Army War College at Washington Barracks (later renamed Ft. McNair), and the newly-created Army Industrial College at Washington Barracks. By this time, the Command and General College at Leavenworth had become firmly entrenched in the Army tradition as preparation for higher command assignments.

The War College allowed more senior officers to develop their skills by assigning study problems to the students. Typically, a class selected a war scenario, such as a war against both Britain and Japan, and the class then broke down into committees to study the personnel, logistical, industrial, training, strategic, and tactical problems associated with that scenario. Instructors critiqued the solutions, but did not provide answers.

The Army Industrial College was started in 1924 to provide advanced instruction to officers in the procurement branches, at a level comparable to Leavenworth for the combat branches. In time, it concentrated on problems of industrial mobilization, and it was transformed into the Industrial College of the Armed Forces.[30]

As a part of the Army, members of the Air Corps participated in the same educational system as members of the ground forces. Yet some of the peculiar requirements of aviation, as well as a general trend towards greater independence of the air arm, led to the establishment of some additional schools. In 1931, the Air Corps consolidated its primary flight training at Randolph Field in Texas, with advanced flight training at nearby Kelly Field. In 1921, it initiated an Air Service Tactical School at Langley Field to provide instruction in the doctrine of air power to senior captains and field grade officers. In 1931, the school moved to Maxwell Field, where it evolved into the Air University. For most of this period, the Air Corps maintained a Technical School at Chanute Field, despite chronic complaints about the poor location and facilities.

The Navy Department also maintained and improved its education system during the inter-war years. After commissioning, officers could receive advanced education either at the Annapolis post-graduate school, or in civilian universities. The Navy War College continued to instruct senior Navy and Marine Corps officers, and offered correspondence courses to non-resident students. Enlisted personnel received their initial training at one of the Navy training stations, and then received more advanced training at a specific trade. As its ships became ever more sophisticated, the Navy required enlisted specialists for such trades as electrician, engine repairman, or radioman.[31]

Having observed the effectiveness of their rigorous training program during World War I, the Marine Corps maintained its recruit depot at Parris Island and added another recruit depot at San Diego near the end of the war. The Quantico Base became an educational center for officers. The school at Quantico also became a center for writing doctrine on amphibious warfare, which became an important Marine Corps responsibility during the inter-war years.

As the United States entered World War II, the level of professionalism of officers and enlisted personnel of all services contributed significantly to the allied victory. Speaking to a Leavenworth class in 1947, Secretary of War Robert C. Patterson commented that:

> The longer I serve with the War Department the more I appreciate what Leavenworth has done for the Nation's safety in the past and its great value to the service for the future.

> It is no exaggeration to say that our victories in World War II were won right here at Leavenworth, perhaps with the aid of a Gettysburg map. Here our great war leaders learned the art of combined arms, the handling of large bodies of troops.[32]

With some variations, his remarks could apply to all military schools.

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CHAPTER 3
MEDICINE

Throughout the history of the armed forces, medical support has increased in complexity and importance. Not surprisingly, the sophistication of military medicine has benefitted from the overall development of medical science during the last 200 years. The armed forces also have contributed significantly to medical science. Although the work of military medical personnel may be most apparent in the treatment of battlefield casualties, their work has extended beyond treatment of the wounded. They have cared for sick and injured personnel during peacetime, and have been responsible for preventive medicine programs within their respective services. Historically, the preventive medicine has been critical to the success of military operations. For most of the time covered by this study, diseases produced more deaths than enemy weapons.

Military Medicine during the Early Republic 1790-1860

During the first half of the nineteenth century, medical science was primitive by twentieth century standards. Doctors did not know of the existence of microorganisms, or much else about the causes of disease. Instead, afflictions were blamed on "vapors" or "miasma." Favorite treatments included bleeding the patient or inducing vomiting. Common medicines encompassed mercury compounds or opiates, although by the end of this time period, doctors began to notice that mercury produced undesirable side effects. People vaguely recognized a connection between disease and diet, living conditions, and cleanliness; however, the idea of preventive medicine remained in its infancy.[1]

Physicians, especially those educated at European medical schools, enjoyed the respect of the community. Yet the medical profession also was open to patent medicine salesmen and other novices. Because surgery demanded a higher degree of skill, surgeons were less likely to be amateurs. They operated without anesthetic, so the best surgeons were those who could work quickly. Surgeons could be effective at treating some injuries and afflictions, if they could avoid infections.

After the Revolutionary War, the Army consisted of only a few companies to guard military stores. However, conflicts with Native Americans in present-day Ohio convinced the government to reconstitute the Army, and to provide medical care for soldiers. Consequently, surgeons were authorized for regiments or posts at levels that varied through time. Before 1813, the Army maintained no central authority for doctors. In that year, the Army created the offices of Physician General and Apothecary General, to supervise medical supplies. Both positions were civilian posts. In 1818, Congress finally recognized the need for better management of medical support by creating the office of Surgeon General, to be filled by a military surgeon.[2]

Malaria, dysentery, and similar diseases proved the most common problems facing the regimental or post surgeon, particularly in southern states. In all cases, widespread alcoholism compounded the doctor's work and encouraged members of the Medical Department to support the temperance movement.[3]

Hospitals and other facilities for the care of the ill were usually in poor condition. The Medical Department regularly complained that post hospitals were so damp, poorly ventilated, or crowded that they hindered the patients' recovery. Ft. Jay in New York harbor had no separate hospital building, so patients were sheltered in casemates (gun portals within the walls of the fort). Even for healthy soldiers, casemates were miserable shelters; sick soldiers found them unbearable.[4]

Aside from supporting soldiers in garrisons, the Medical Department accompanied the Army on the most important campaigns of this time: the Black Hawk War, the Second Seminole War, and the Mexican War. In all cases, disease proved far more deadly than battles. A cholera epidemic during the Black Hawk War decimated entire regiments before they reached Wisconsin. During the Seminole War, the summer months raised the sickness rate to the point where half of the soldiers were incapacitated. Although the Army faced substantial numbers of battlefield casualties during the Mexican War, disease still posed the greatest danger to soldiers. Of the estimated 100,454 soldiers serving in the Army during the Mexican War, 1,549 died in battle and 10,970 died from disease, creating a seven to one ratio of disease deaths to battle deaths. Malaria, dysentery, and scurvy remained the most serious problems. Disease rates were higher in volunteer regiments, which were exposed to the close living conditions of military life for the first time.[5]

During the Seminole and Mexican Wars, the chronically ill and seriously wounded overloaded unit treatment facilities. During the Second Seminole War, the Medical Department established general hospitals near the most important supply depots. General hospitals followed the armies during the Mexican War, occasionally using a building for shelter, but more often using tents for hospitals.[6]

Even with the limited resources available to the Medical Department, an Army surgeon made one of the most noteworthy contributions to early medical science. In 1822, William Beaumont, the surgeon at Ft. Mackinac, located on the straits between Lake Huron and Lake Michigan, was asked to treat a French-Canadian named Alexis St. Martin for a gunshot wound in the chest and stomach. The wound had left an opening in the stomach that had not healed completely, and Beaumont realized he had an opportunity to observe the digestive process. He therefore persuaded St. Martin to remain under his care while he studied the stomach in operation and drew samples for chemical analysis. By 1833, Beaumont published his findings, which described the movements of the stomach and the secretion of gastric acids.

Although these experiments brought professional acclaim to Beaumont, St. Martin was not so happy about being the subject of the experiment. Although St. Martin repeatedly attempted to leave Beaumont's care, the doctor persuaded him to return. Even after he left Beaumont, St. Martin could not escape his undesired fame. After St. Martin's death in 1880, the Army wanted to acquire his famous stomach for its medical museum. His relatives denied that request with a telegram stating "Don't come for autopsy; will be killed." St. Martin's neighbors guarded the grave site to prevent an exhumation.[7]

Medicine within the Navy also developed slowly during the antebellum period. From the Navy's beginnings during the 1790s, surgeons were assigned to ships and Navy yards. However, Navy doctors experienced little overall supervision. In 1828, Congress authorized the position of Fleet Surgeon. In a reorganization of the Navy in 1842, Congress created the Bureau of Medicine and Surgery, under the supervision of the Navy's Surgeon General.

In 1798, the government created the Marine Hospital Fund to benefit merchant sailors who otherwise lacked medical care. In 1799, Congress expanded this fund to include officers and enlisted men of the Navy and Marine Corps. From 1799 to 1811, the government used the fund to provide for both Navy personnel and members of the merchant marine. Sailors on merchant vessels had 20 cents per month deducted from their pay for promised medical care. Congress separated the two funds in 1811 to create a separate Navy Hospital Fund, which also required the contribution of 20 cents per month from officers and enlisted men of the Navy and Marine Corps. The Marine Hospital Fund continued to provide for merchant sailors, and became the U.S. Public Health Service in 1902.[8]

Even after the authorization of the Navy Hospital Fund in 1811, little progress was made in building Navy hospitals until the 1820s. During that decade, the Navy began to acquire land for hospitals near its yards: Washington, D.C. (1821); Chelsea, Massachusetts (1823); and Brooklyn, New York (1824); Philadelphia, Pennsylvania (1826); and Norfolk, Virginia (1827). In 1827, permanent hospital construction began at Norfolk and Philadelphia. Architect William Strickland worked on the Philadelphia Naval Asylum; Philadelphia architect John Haviland designed the Norfolk Naval Hospital, Virginia. The early navy hospitals established a tradition of notable architectural styles. These first naval hospitals were imposing structures in the tradition of early American public buildings and often reflected classically-inspired architectural styles. For example, the hospital at Norfolk, was designed as a central block building with a columned stone portico, exemplifying Greek Revival architecture. The Norfolk hospital was the first to receive patients, in 1830.[9]

Army Medicine during the Civil War and at Frontier Posts 1860-1890

Within these 30 years, significant medical advances eventually changed the field of medicine; however, the actual practice of medicine by military surgeons advanced slowly during these years. Louis Pasteur and Joseph Lister made significant advances in the understanding of the transmission and treatment of disease during the mid-nineteenth century, but the Civil War preceded the application of these and other new discoveries, except for surgical anesthetics. After the war, military doctors at isolated posts lacked the facilities to profit from Pasteur's or Lister's work, even if they appreciated its significance. Preventive medicine was in infancy during these years. Doctors vaguely understood that waste disposal, general cleanliness, and diet affected the health of a unit. Yet they still lacked a detailed knowledge of how diseases were spread. Even after the discovery of bacteria as a cause of disease, doctors did not understand all the ways bacteria could spread from one person to another.

The Civil War was one of the bloodiest conflicts in history. For both services, the resulting medical problems of the Civil War far exceeded any problems in their previous experience. For the Army, medical problems were especially acute. Large concentrations of soldiers, unaccustomed to living in camps, suddenly were exposed to new diseases. New weapons technology, especially the minie ball, produced massive numbers of battlefield casualties. The Medical Department, which was designed to care for a peacetime army of about 16,000 soldiers, suddenly needed to support a wartime force of more than half a million men. Soldiers suffered horribly from both wounds and disease. The Union Army lost 138,154 men in battle and 221,374 men to deaths from other causes.

Even so, the Medical Department improved its performance during the course of the war to provide credible medical care for the soldiers given the state of medical knowledge. Some of the changes instituted provided lasting benefits to the Army. Much of these improvements resulted from the work of William A. Hammond, Surgeon General from April 1862 to August 1864, and Jonathan Letterman, who served as Medical Director of the Army of the Potomac. Despite an arrogant manner that eventually led to his downfall, Hammond displayed both energy and vigor in his work. Letterman was also an innovative medical officer, especially in caring for the wounded.

One of the most important changes in Army medicine during the Civil War was the creation of an ambulance corps. Previously, each regiment was responsible for removing its wounded from the battlefield, using band members or whoever was available. During McClellan's retreat in the Peninsular campaign, this system was completely ineffective; wounded soldiers were not evacuated rapidly and stragglers often took the place of wounded on hospital boats. After this catastrophe, Jonathan Letterman was appointed medical director of the Army of the Potomac.

Letterman created a special ambulance corps under the control of medical officers and charged them with responsibility for evacuation of the wounded. Although he had little time to develop these new procedures before the battle of Antietam, Letterman managed a relatively efficient evacuation of the wounded in that battle. With the success of an ambulance corps firmly established, Letterman then reorganized and improved the field hospital system of the Army of the Potomac. In time, these innovations became standard practice for European and American armies.[10]

Another important feature of medical care during the Civil War was the general hospital system. These hospitals were used to shelter soldiers of any unit, and were under the direct supervision of the Surgeon General. Because field hospitals lacked the ability to provide long-term care for soldiers with serious wounds or illnesses, these patients were evacuated to general hospitals. At first, the general hospitals were improvised facilities, placed in available buildings. The Army later developed a "pavilion" type of hospital, which consisted of wards physically separated from one another and connected by corridors. Temporary wood frame hospitals of World War I and World War II followed a similar arrangement. Because doctors mistakenly believed that diseases were transmitted through "vapors," they believed the pavilion design would prevent the spread of disease. Although their understanding of epidemiology was wrong, the physical separation of patients in these hospitals produced a low death rate for the time. By the close of the war, the Army had 204 general hospitals, with 136,894 beds.[11]

With the majority of illnesses and deaths arising from diseases rather than wounds, Hammond and Letterman, among others, expressed the opinion that medical personnel should become involved in preventive medicine. Both Hammond and Letterman instructed medical inspectors to make recommendations on preserving the health of the soldiers. Hammond wrote a treatise on military hygiene and succeeded in establishing an Army Medical Museum, which later conducted important work in medical science. He also proposed an Army Medical College that taught Army doctors the particular problems of military medicine, but the War Department did not support his suggestion.[12]

Despite his innovative approach, or perhaps because of it, Hammond was unpopular with his more conservative colleagues. His difficulties were compounded by an acrimonious relationship with Secretary of War Edwin Stanton. From the beginning of his tenure, Hammond had quarreled with the Secretary of War, and the contentious personalities of both men contributed to on-going feuding. Hammond then undermined the support of his fellow surgeons by restricting the use of calomel, a mercury compound used as a purgative. Suspecting that mercury produced harmful side effects, Hammond removed it from the medical supply system, except for use in extreme cases. Shortly afterwards, Stanton obtained a court-martial conviction of Hammond for a technical violation of procurement regulations. Although Hammond eventually had the conviction reversed, his Civil War career ended. Shortly afterwards, Letterman also resigned from the Army.[13]

Another innovation of medical care during the Civil War was the introduction of civilian volunteers on a large scale. Recognizing the need for additional medical support, prominent physicians and laymen organized the United States Sanitary Commission. This organization provided invaluable support in the form of labor and medical supplies, though Army doctors often resented the tendency of the Sanitary Commission to intrude upon their domain. Women also contributed their services as nurses, in unprecedented numbers. Some of these women were organized and paid by the government, while others were volunteers. Their work helped lay the foundations for nursing as a profession for women during the late nineteenth century.

After the war ended, the Army returned to its pre-war mission of policing the frontier regions against Native Americans. Doctors again found that most of their time was spent in small

units, operating under primitive conditions. Like most other buildings on a frontier post, hospitals were temporary buildings, rudely constructed and lacking sterile facilities for surgery. Some doctors preferred these buildings because they could be torn down after the accumulation of sufficient "vapors."[14]

The following description of a case at Ft. Washakei, Wyoming powerfully illustrates the difficulties faced by the military surgeon on the frontier:

> ...a cavalry soldier was accidentally shot in the right thigh, anterior aspect, upper third. ...This operation was done in the ward on a mess table borrowed from one of the troop barracks, for our three attendants ate in the kitchen and we had no mess tables. Collateral circulation was not established and soon it was evident that gangrene of the foot and leg was inevitable. While waiting for a line of "demarcation" to form between dead and viable tissues, I was called to the hospital one night to find that secondary hemorrhage had set in. The only chance it seemed to me of saving the man's life was amputation at the hip-joint.
>
> At night, by the light of a few candles the operation was done. The anesthetic was given by the hospital cook, a private of cavalry. The hospital steward recently appointed fainted at the first stab of the knife, and was shoved under a bed and left to come to in his own good time. A patient in the ward, a cavalry private, crawled out of bed, told me he had worked in a drug store before enlisting and offered to help, and he did very well, and disarticulation was soon completed. The patient died before daybreak.[15]

Despite the seeming bleakness of the state of medical care, medical science verged on entering a new era during the 1870s and 1880s, one which benefitted both the military and society at large. In France, Louis Pasteur discovered that microbes caused disease. Shortly afterwards, the English surgeon Sir Joseph Lister applied Pasteur's findings to the practice of surgery. Lister ploneered the theory that germs entering the body during an operation were the principal cause of post-operation infections. He advocated a system of antiseptic surgery, using carbolic acid as a disinfectant to prevent infections. Some of his procedures, such as spraying a carbolic acid mist through the room while operating, were discontinued. However, his work revolutionized surgical practices in the western world. Following Lister's visit to the United States in 1876, the Surgeon General authorized the use of carbolized dressings, sutures, and sprays.[16]

The Army Medical Department contributed to the growth of medical science through its medical museum and medical library. The museum conducted important work in pathology after the Civil War. The medical library, begun in 1836 with a small collection of medical literature, rapidly expanded after the Civil War. Starting in 1880, the Medical Department began producing a bibliography of medical literature based on its library collections. It followed this bibliography with the *Index Medicus*, an ongoing bibliography of medical literature. The library and bibliographic aids proved to be invaluable to medical researchers. In 1956, the library was transferred to the Department of Health, Education and Welfare to become the National Medical Library. The *Medical History of the War of the Rebellion*, also produced during this time, marked an increasing interest in recording military doctors' experience.[17]

The publication of Circular No. 8, *A Report on the Hygiene of the United States Army*, by the Surgeon General's office in 1875, represented further development of preventive medicine within the Army. This report called attention to the deplorable living conditions among soldiers in frontier garrisons as a cause of death and disease among soldiers. This work reinforced the belief that diseases could be reduced through a proper environment, and that a principal responsibility of military doctors was preventive medicine.

Thus, by 1890, the foundations had been laid for the rapid improvements in military medicine that occurred during the ensuing years. During the Civil War, the Army gained experience in evacuation and treatment of massive casualties. Doctors in the military and civilian communities gradually came to believe that microorganisms were the principal cause of disease. During the next three decades years, doctors learned to identify specific microbes and to find treatments and vaccines.

Military Medicine in the Progressive Era 1890-1918

During the Progressive Era, doctors linked specific microorganisms with each disease. From these discoveries, they were able to find vaccinations and treatments. Other doctors studied ways in which diseases were carried, and identified insects, food preparation, waste disposal, and physical contact as potential transmitters of disease. These discoveries and wartime medical experience during the various conflicts of this period led to improved living conditions and medical treatment for military personnel.

The appointment of George Sternberg as Surgeon General in 1892 was indicative of the new prominence of scientific medicine in the Army Medical Department. Sternberg made his reputation in bacteriology, rather than in service with units, arousing resentment among his colleagues. One of his fellow surgeons commented, "Look at Sternberg, over there in New York, spending all his time with a microscope. Can you tell me one earthly bit of good Sternberg is to the Medical Corps?"[18]

One of Sternberg's first actions was to assemble a Medical School, using vacant rooms in the Army Medical Museum and Library in Washington, D.C., and reassigning personnel as lecturers. Thus, without a costly Congressional appropriation, Sternberg improved the professional quality of medical care. Doctors entering the Army received instruction both in medical science and in the distinct requirements of Army medicine.

At a different time, Sternberg's tenure might have been an unqualified success. He helped to point Army medicine towards the twentieth century. Yet medical problems that resulted from the Spanish-American War diminished his reputation. Many of these problems resulted from accumulated years of neglect beyond the control of the Surgeon General, and from indifference towards medical affairs by line officers. A more aggressive Surgeon General might have reduced some of these problems, but Sternberg preferred to rely on traditional procedures and lines of authority. He wrote an excellent circular on camp hygiene, but did not require reports to ensure that his directives were followed.[19]

Regardless of who served as Surgeon General, the Medical Department was wholly unprepared for the Spanish-American War. The Army had no experience in mobilizing volunteers since the Civil War, and many of the medical personnel in the volunteer regiments lacked an understanding of basic military hygiene. Because Sternberg did not require reports for camp or hospital medical officers, he was unaware of impending problems until the situation became unmanageable. Distribution systems for large quantities of medical supplies were inadequate, and suffered from a general breakdown in the supply system. Even if these problems had not existed, the infant science of epidemiology was not advanced enough to prevent the spread of disease. People did not yet understand all the ways germs moved from one person to another, and soldiers and line officers lacked the medical knowledge to appreciate the importance of Medical Department advice.[20]

The earliest and worst medical problem of the war was typhoid fever outbreaks within the United States. During the early months of the war, volunteers hastily assembled at temporary

encampments. At Camp Russell Alger, near Washington D.C., the site was selected on May 8 and the first soldiers began to arrive on May 13. Although water was available from springs, soldiers lacked the time to construct sewage disposal facilities. Latrines (called sinks) were dug, often too close to kitchens. Soldiers were crowded into hastily-erected tents. At the time, doctors believed that a poor water supply was the only means of spreading typhoid, so were unconcerned about sewage disposal or crowded conditions. As soldiers arrived in camps, however, some were already infected with typhoid. The use of trench latrines rapidly spread the disease. As the disease reached epidemic proportions, other practices hastened its spread. For example, soldiers detailed to a regimental hospital to nurse the sick might later be detailed to the mess facilities, where they spread typhoid among their comrades. Although these practices were in accordance with the best medical knowledge of the time, they produced fearful epidemics of typhoid.[21] As typhoid spread, other common camp diseases, such as measles, dysentery, and malaria, continued to pose health problems.

Soldiers who avoided these diseases and reached Cuba found Spanish weapons to be the least of their worries. Although some sharp engagements occurred, wounds or accidents produced only about 540 of more than 4,000 deaths in that war. During the height of the battles, the medical facilities were on the verge of being overwhelmed, but survived with the assistance of Clara Barton and the American Red Cross.[22]

After the victory against Spain, Americans in Cuba fell victim to malaria and yellow fever. Malaria, more common than yellow fever, usually was not fatal. However, it left the soldiers too debilitated to perform their duties and more susceptible to yellow fever. On August 4, General Shafter, the V Corps Commander, notified the War Department that his corps "must be moved at once or it will perish." His recommendations were supported by nine other general officers, the chief surgeon, four division surgeons, and the former Assistant Secretary of the Navy, Theodore Roosevelt. In response, the War Department decided to hasten the evacuation of the Americans to Montauk Point, New York.[23]

The scene at Montauk Point seemed to be a culmination of all the previous mishaps in medical care. The War Department originally planned a gradual return of forces to the United States, and had been constructing a reception point at a deliberate pace. Upon notification of the imminent return of American soldiers, the Quartermaster and Medical Departments did their best to accelerate construction at the reception point, which they named Camp Wikoff. However, the first soldiers to return were compelled to sleep on the ground and to endure shortages of rations and medicine while the camp was under construction. Because Montauk Point was only a short distance from New York City, reporters from the city's papers visited the camp and recounted stories of soldiers suffering from the neglect of the Army. The American public viewed Army incompetence as the cause of the soldiers' suffering and deaths.[24]

Despite this view, many of the problems were beyond the capabilities of medical science at that time. The Medical Department learned rapidly from its mistakes. By August and September, units were moved to new locations with adequate hospitals and medical care. The reception point at Camp Wikoff steadily improved, although it remained a source of vexation to soldiers and doctors. Units sent to the Philippines received adequate medical supplies.[25]

The Spanish-American War also produced some innovations in medical care. Most important was the use of contract nurses, both in the United States and overseas. By September of 1898, the Army employed more than 1,100 women; their efforts led to the establishment of the Army Nurse Corps shortly after the war. Another innovation was the acquisition of hospital ships by the War Department. The Surgeon General also expanded six post hospitals into general hospitals to accommodate the flood of patients.[26]

The general perception of a failing health care system had a profound effect upon the Army Medical Department during the beginning of the twentieth century. Line officers could no longer ignore medical care as unimportant to military operations; they came to realize that soldiers who died in camp posed the same loss as soldiers who died in battle. The Medical Department was expanded and reorganized.

One of the most visible new activities of the Army Medical Department was increased research on the spread of diseases. After the close of the Spanish-American War, the Army organized boards of medical officers to investigate diseases, and supported laboratory research of disease transmission. With the annexation of the Philippines, the Army expanded its interest into tropical and Asian diseases, as well as typical American diseases.

In 1898, the Medical Department appointed a board consisting of Walter Reed and two other medical officers to investigate the causes of the spread of typhoid within the camps. They concluded that contaminated water was not the principal means of spreading typhoid; rather, the disease was spread through poor sanitation practices and confined living quarters. The report led to new camp sanitation methods and procedures for controlling the spread of typhoid. In 1909, the British Army introduced a typhoid vaccination following a disastrous experience with typhoid in the Boer War. The U.S. Army quickly adopted the vaccination, and the apparent success of the vaccination within the Army encouraged its use within the general public.[27]

Another well-publicized Army effort into disease research was the campaign against yellow fever. An investigating board chaired by Reed confirmed that yellow fever was caused by a virus and transmitted by mosquito bites. They performed this research in Cuba, using volunteer soldiers to test their theories. Some volunteers died during the experiments. In 1901, immediately after Reed's report, the Chief Sanitary officer in Cuba, William Gorgas, eliminated yellow fever from Havana by driving out the mosquito. Later Gorgas made construction of the Panama Canal possible by reducing the mosquito population in The Canal Zone and thereby minimizing the dangers from yellow fever and malaria. Reed and his associates not only minimized the spread of yellow fever, but they opened the possibilities of considering insects as disease vectors.[28]

The Army undertook other efforts at preventive medicine. Doctors in Puerto Rico discovered that the hookworm was a cause of anemia. In the Philippines, Army doctors experimented with the relationship between beri-beri and diet. The Medical Research Boards in the Philippines continued to perform research on both animal and human diseases. Army doctors even developed improved footwear for infantrymen.[29]

The beginning of the twentieth century was also a time of reorganization for the Army, including the medical corps. The creation of a General Staff and Chief of Staff in 1901 clarified the lines of responsibility for the Surgeon General. He now reported through the Chief of Staff on medical matters. In February 1901, Congress reorganized the Medical Department, and authorized the Nurse Corps and dental surgeons. Other additions to the medical department included a Veterinary Corps established in 1916, and a Sanitary Corps, established in 1917. The Sanitary Corps was for non-medical personnel in medical support roles; it was the precursor of today's Medical Service Branch. To meet the Army's wartime needs, in 1908 Congress authorized a medical reserve corps, the first federally-organized reserve component and a precursor to the Army Reserve.[30]

Another result of the Spanish-American War was increased attention to medical education for line officers and military education for medical officers. In 1908, Major E. L. Munson reported to the Army Service Schools at Ft. Leavenworth, a forerunner of the Command and General Staff College, as an instructor in military hygiene. He integrated the use of medical units in the Leavenworth curriculum. By 1911, the school had established a policy that no combatant problem

should be considered solved unless the solution considered the medical aspects. Two books on medical support were published almost simultaneously by the Army Service School and the Army War College. At about the same time, the War Department established a Medical Field Service School at Ft. Leavenworth, which later was moved to Carlisle Barracks in 1920. This institution focused on military matters, while the Army Medical School focused on medical subjects.[31]

A final change in the Medical Department at the beginning of the twentieth century was the creation of peacetime general hospitals. In 1887, the Army and Navy had created a small general hospital at Hot Springs, Arkansas, but most soldiers were treated in post hospitals, until the Spanish-American War and the Philippine Insurrection. To treat sick and wounded soldiers returning from the Philippines, the Army established Letterman General Hospital at the Presidio, San Francisco. Sternberg Hospital in Manila and Tripler Hospital in Honolulu provided care to soldiers in the Philippines and Hawaii. To treat an increased number of tuberculosis patients, the Army built a special general hospital at Ft. Bayard, New Mexico. During the Spanish-American War, the Army had built a temporary general hospital at Washington Barracks. In 1908, the Army relocated the temporary facility to the northern part of the District of Columbia to form one of the first peacetime general hospitals. The Medical School and Medical Museum also were moved to the same site, later renamed the Walter Reed Army Medical Center. General hospitals were intended to treat all eligible patients, and general hospitals in the United States were under the direct supervision of the Surgeon General.[32]

When the United States entered World War I, the Medical Department and the state of medical science had improved so much that for the first time, battlefield deaths were comparable to deaths from disease. Some of the traditional scourges of the Army, such as typhoid, dysentery, and intestinal diseases, were avoided. The most serious illness was a deadly influenza epidemic. Other problems included venereal disease, pneumonia, which was not yet treatable, and louse infestation, which resulted from conditions in the trenches.[33]

Ft. Riley, Kansas, played an important role in one of the greatest medical disasters of the early twentieth century. The best available evidence indicates that a virulent form of influenza first appeared in March 1918 at Camp Funston, a temporary cantonment located on the Ft. Riley reservation. From there, the flu was carried to Europe aboard troopships. In Europe, the virus mutated into a more deadly form and spread throughout Europe and Asia, killing an estimated 30 million people before the disease played itself out.[34]

The health of the American forces was, in part, the result of improved conditions of training cantonments in the United States. To avoid the disasters of the Spanish-American War, the War Department built suitable housing facilities before accepting units. In some of these camps, soldiers were housed in tents, while others used temporary wooden barracks. All facilities contained proper water and sewage facilities, plus sufficient space to minimize the spread of disease. Training cantonments also contained hospital facilities, usually consisting of temporary wooden buildings. The Army also constructed additional general hospitals, including General Hospital No. 21 near Denver, Colorado (later named Fitzsimons General Hospital), which was designed specifically to treat tuberculosis patients.[35]

Even if the Medical Department could reduce the threat from disease, it could not prevent casualties from enemy weapons. Therefore, it focused its energies on rapid treatment of the wounded (Figure II-3). Its treatment program in the theater of war consisted of an echelon system of hospitals. After receiving first aid at a regimental aid station, soldiers were moved to a field hospital in the division rear. Doctors at the field hospitals stabilized the patient before he was moved to larger hospitals. Evacuation and mobile hospitals performed essential surgery so that the patient could be evacuated by rail to a base hospital. Base hospitals, located in the rear areas, provided long-term care. Frequently, these were grouped into hospital centers, which

contained between 10,000 and 25,000 beds. These were either rented buildings, hastily constructed buildings, or tents. Although the system was overloaded with patients during the major offensives and during the influenza epidemic, the efforts of doctors, nurses, and corpsmen made the system work to achieve better recovery rates than during earlier wars.[36]

Thus, by World War I, the Army medical system had vastly improved from the primitive medical care of the Spanish-American War. In part, these changes resulted from a general improvement in the state of medical knowledge, in which the Army played an important role. Internal improvements in the Medical Department and a recognition of its importance by line officers also helped improve the health care system. The unfortunate experiences at the beginning of the century had taught military leaders to provide for preventive medicine and for the care of sick and wounded. Although medical care in World War I had not been perfected, the Army never again experienced the medical catastrophe of the Spanish-American War.

Navy medicine also expanded and improved during this period. Medical care during the Spanish-American War was not the traumatic experience that it was for the Army. Steady progress characterizes the history of the Navy Medical Department.

Towards the close of the nineteenth century, the Navy began to recover from the doldrums of its post-Civil War era. Steel warships replaced wooden sailing ships, and the entire fleet was expanded. As late as 1890, the Secretary of the Navy estimated that the United States ranked twelfth among naval powers, somewhere below Turkey and China.[37] By 1907, President Theodore Roosevelt could dispatch the "Great White Fleet" around the world with a navy that commanded the respect of even Great Britain.

Navy hospital construction paralleled the overall growth in the Navy. In 1894, a total of 823 hospital beds were sufficient to accommodate a relatively small naval force, though many of the hospitals were showing the effects of age. For example, the Norfolk Navy Hospital had been constructed in 1830, and the Chelsea, Massachusetts, hospital dated from 1836. Beginning in the 1890s, these hospitals underwent extensive renovation and, in some cases, new buildings were constructed. Heating and electrical systems were installed, and laboratories, X-ray facilities, and operating rooms were added. The construction of new buildings to replace the outdated hospitals proved a mixed blessing, as in the case of Norfolk Navy Hospital, where doctors and patients were forced to use tents while the new building underwent construction.[38]

Another change in Navy medicine during this period was the development of peacetime hospital ships. The Navy had experimented with hospital ships during the Civil War, and then discontinued their use. During the Spanish-American War, the Navy purchased a steamer, which it converted into the ambulance ship *Solace*. This ship was on station near Cuba when the Marines landed at Guantanamo Bay and the two navies fought at Santiago. The ship collected wounded Marines, U.S. sailors, and Spanish sailors to treat and evacuate them. Finding that it still had some empty beds, the *Solace* then collected some U.S. soldiers. For the remainder of the war, it transported sailors and soldiers back to the United States.[39]

Shortly after the Spanish-American War, the Russian and Japanese navies also employed hospital ships. Their successful use convinced the Navy's surgeon general of the value of maintaining a hospital ship during peacetime. After some discussion, the Navy Department acquired an old hospital ship, the *Relief*, from the War Department and renovated it. For years, however, the ship sat idle because the Bureau of Navigation did not furnish a line officer to command it. Finally, President Roosevelt personally authorized use of a medical officer to command a hospital ship with a merchant crew. The *Relief* joined the Great White Fleet and sailed with it as far as the Philippines, where the ship remained permanently. In 1909, the *Solace*

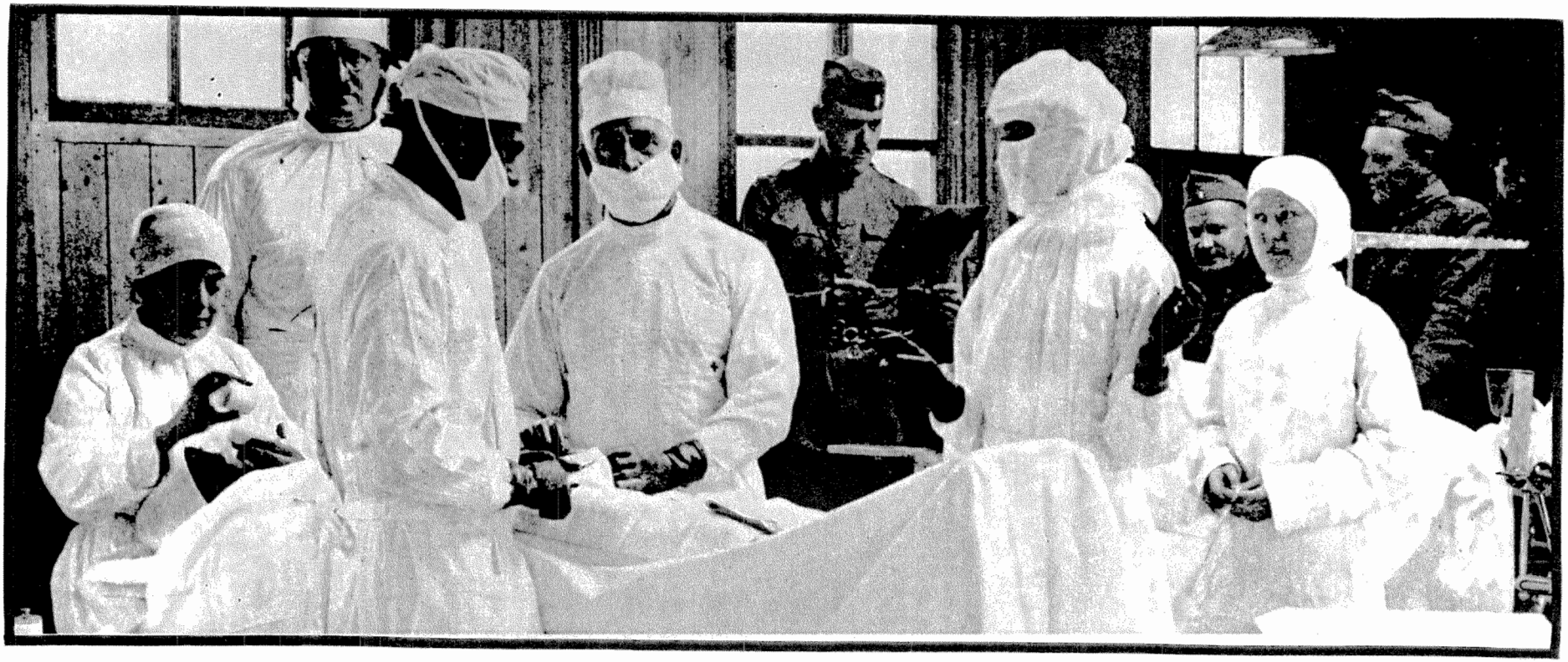

Figure II-3. By World War I, military medicine had achieved a measure of effectiveness in battlefield surgery. Shown here are doctors and nurses preparing for surgery in France during the war. (Courtesy of the Military History Institute)

was recommissioned, and in World War I, two passenger liners were converted into the *Mercy* and the *Comfort*.[40]

Like the Army, the Navy also introduced a Nurse Corps and a Dental Corps at the beginning of the twentieth century. In 1908, Congress approved the creation of a Navy Nurse Corps after the repeated requests of the Surgeon General. The Dental Corps was authorized by Congress in 1912, with an authorized strength of only 30 dentists. With the American entry into World War I, however, the Dental Corps increased to more than 500 dentists.[41]

The Navy's interest in preventive medicine and medical education increased with the establishment of a Naval Museum of Hygiene. The Museum began as a laboratory for investigating hygiene-related subjects, and gradually acquired a collection of specimens and books in the process of its work. By 1894, the Museum had grown too large for its rented quarters; it moved into the former Naval Observatory building in Washington, D.C., which the Naval Observatory recently had vacated for its new facility in northwest Washington, D.C. From there, the Museum performed valuable work in industrial medicine, both on ships and in shore facilities. In 1902, the Navy established a Navy Medical School at the same site, and in 1903 the Washington Navy Hospital also moved to these grounds. Though the museum was closed in 1905, the school and hospital continued to support the Navy. The proximity of these two institutions allowed instructors to assist at the hospital, where students could receive clinical experience. The Washington Hospital remained in that location until World War II, when it moved to suburban Maryland to become the Bethesda Naval Hospital.[42]

Because the Navy Medical Department also supported the Marine Corps, Navy doctors accompanied the Marines who served with the Army in France during World War I. A total of 60 Navy medical officers, 12 dentists, and 500 enlisted men served with the Marines Corps, with 122 killed in action. One Navy doctor went to France as a battalion surgeon with the Marines, and later found himself in command of an Army field hospital. He finished his tour as the sanitary inspector for an Army division.[43]

With American territorial expansion following the Spanish-American War, the Navy received responsibility for administering some of the new island territories, including Guam and the Virgin Islands. Navy personnel discovered shockingly poor medical conditions among the native inhabitants, and established hospitals and introduced modern sanitation practices to alleviate the poor conditions. Because of extensive Marine Corps intervention in Haiti, the Navy Medical Department also provided medical assistance there.[44]

Few periods saw such rapid changes in the state of medical care as the years between 1890 and 1918. At the beginning of this period, doctors began to realize that microorganisms caused many common diseases. By the end of that time, they began to understand how microbes moved from one person to another, and how to prevent the spread of disease. Medical care for both the Army and Navy improved immeasurably. During the Spanish-American War, hundreds of soldiers died because of a lack of what today would appear elementary hygiene. By World War I, doctors had reduced many diseases to manageable levels and made progress in treating battlefield wounds. The Army's introduction of general hospitals and the Navy's improvement of its hospital facilities increased the level of care provided to the military during both war and peacetime.

Inter-War Years 1919-1940

Despite a general trend toward fiscal retrenchment during the inter-war years, the medical branches of the services maintained a respectable level of progress. They obtained funding for

new hospitals and continued scientific research. While their gains were not as dramatic as during the previous era, they continued the trend of improving medical care for military personnel. These improvements are most readily apparent in the renovation of and construction of large, permanent hospitals according to the latest theories of hospital design.

The Army improved both its general and post hospitals. During the 1920s and 1930s, the Army began to renovate the Walter Reed Army Medical Center, located in the northwest part of the District of Columbia. By the mid-1930s, the center had more than 100 brick Georgian-style buildings and combined a hospital with a research center. Beaumont Hospital was built near Ft. Bliss, Texas, in 1921 to provide medical care for soldiers serving on the Mexican border. To care for tuberculosis patients during and immediately after World War I, the Army had built Fitzsimons General Hospital near Denver. After nearly two decades of minimal improvements, the Surgeon General in 1936 ordered military planners to develop plans for a new hospital building at Fitzsimons. The new building was to follow the recent practice of concentrating wards in a single tall building, rather than the dispersed plan of World War I hospitals. In 1938, Congress approved funds for construction of the new 610-bed hospital, which at the time was the largest single hospital structure ever built by the Army. The main hospital building opened just four days before the attack on Pearl Harbor.[45]

The War Department also managed to obtain Congressional authorization to improve post hospitals. The need for better hospitals was especially acute where the Army still used World War I temporary buildings. These simple wooden structures had exceeded their projected life expectancy and were serious fire hazards. In 1925, the Secretary of War singled out hospitals for special consideration in his plea for additional construction funding.

> "No graver problem faces the War Department to-day than that of providing adequate shelter. The officers ... are in constant dread of ... [fire] even greater than their apprehension of fire in quarters and barracks is their dread of a serious fire in the ... hospitals. ... The longer the Army is compelled to use war-time structures for housing and hospitalization purposes the graver this danger becomes."

In 1926, Congress authorized a special fund from the sale of surplus Army property for construction purposes. Part of this fund was used to build station hospitals. During this period, many World War I training cantonments received permanent housing and hospitals, as well as other necessary facilities. Even so, progress remained frustratingly slow. In 1934, the Army began a long-range program to improve hospitals. By 1939, the Surgeon General estimated that of all of the Army post hospitals, only 25 hospitals were modern, fire-resistant buildings, and only 50 of the remainder were worth improvements.[46]

Navy hospital construction also continued during the inter-war years. In 1922, the Navy established a hospital on the Pacific Coast, at San Diego. Philadelphia received a new hospital in 1935. Towards the close of the inter-war period, in 1939, the Navy began work on the Naval Medical Center, in the Washington suburb of Bethesda, Maryland, which like Army general hospitals of the late 1930s, incorporated a large tower design instead of the low-scale, dispersed wards of earlier hospitals.[47]

Progress in medical research and preventive medicine continued to build on the foundations laid during previous years. Within the civilian community, preventive medicine and public health were achieving a reputable status, as indicated by the creation of public health schools at Harvard and Johns Hopkins. In 1930, the Army published its first edition of *Military Preventive Medicine*. Army doctors performed research on treatment of compound fractures,

transmission of dengue (a tropical fever), and effects of modern bullets on the body. Research into the effects of modern bullets resulted in improved surgical procedures that reduced the number of deaths from wounds. The Army also discovered a chemical substitute for quinine in treating malaria. During World War II, when large numbers of Americans operated in malarial regions, this substitute was extremely important in overcoming shortages of quinine.[48]

Another significant contribution of the military in medicine was the emergence of aviation medicine. Flying affected a pilot through cold temperatures, loss of oxygen, decrease in air pressure, and the effects of aerial movements. The Army Air Service established a Medical Research Laboratory at Hazelhurst Field in 1918. It was moved to Mitchell Field, New York in 1919, and became the School of Aviation Medicine in 1922. The first textbook on the subject, *Aviation Medicine*, was published by the school commandant in 1926. A second textbook on aviation medicine, *Principles and Practice of Aviation Medicine*, was published by Major Harry G. Armstrong, who later became Surgeon General of the Air Force. Armstrong also helped build a centerfuge to study the effects of acceleration on the human body.[49] During the 1930s, the Air Corps operated a School of Aviation Medicine and an Aerial Medical Research facility at Randolph Field, Texas.[50]

Women in Military Medicine

The history of women in the military began with the health-care fields. Except for the brief use of women auxiliaries during World War I, the only officially recognized participation of women in the military prior to 1940 came in the medical fields.

Women, especially relatives of sick soldiers, performed occasional *ad hoc* nursing care before the Civil War, but officially, care of the sick was performed by soldiers detailed for that purpose. During the Crimean War, Florence Nightingale had established a precedent for women performing nursing duties, which was applied during the American Civil War. Recognizing the potential for women to provide medical care, Dorothea Dix, a noted reformer of jails and of hospitals for the mentally ill, offered her services to Secretary of War Stanton in April 1861. Stanton accepted her offer of help, and in June appointed her "Superintendent of Female Nurses." In August, Congress authorized women for work in hospitals, and set their pay at 40 cents per day.[51]

Dix had strong ideas of what she desired. A typical recruiting circular noted that: "No woman under 30 years need apply. ... All nurses are required to be very plain-looking women. Their dresses must be brown or black, with no bows, no curls or jewelry, and no hoop-skirts." She discouraged the use of Catholic women, "if a Protestant could be substituted." She also instructed that nurses "must be in their own rooms at taps, or nine o'clock ... must not go to any place of amusement in the evening; must not walk out with any patient or officer except on business."[52] Thousands of young women served as nurses, many of them worked with the Sanitary Commission or else as unofficial volunteers. In 1863, the Secretary of War authorized the Surgeon General to bypass Dix and appoint women who did not meet her standards. Despite Dix's opposition to Catholics, many nuns served as nurses during the war.

Because nursing was not yet an established profession, no standards existed for nurses' duties. They were expected to cook, to clean, and to care for the patients. Nurses received no particular medical training, and their relations with doctors and male attendants were not delineated clearly. The latter point led to friction between doctors and nurses, as some doctors complained that these women defied their orders, and some women complained of drunken or incompetent doctors.[53] For the hundreds of thousands of soldiers in the hospitals, these nurses were quite popular. In accordance with the Victorian ideals of true womanhood, they were

deemed more naturally tender than the men. Moreover, the poor quality of most male attendants made these women especially welcome. Their work opened nursing as a viable career for women after the war ended.

By the Spanish-American War, nursing had become a respected profession for women, with definite educational requirements and professional standards. By 1898, 500 schools of nursing were established in the United States, producing thousands of nurses.[54] Surgeon General Sternberg was willing to employ female nurses during the Spanish-American War. Among other problems in the Medical Department, male hospital attendants were detailed from line regiments, and often were the worst available men. Consequently, Sternberg authorized the use of professional nurses under contract as nurses for hospitals in the United States and overseas. He turned to Dr. Anita McGee, one of the few female physicians of the time, to supervise nursing services. She was appointed Acting Assistant Surgeon, and received responsibility for the contract nurses.[55]

Even more than during the Civil War, nurses proved their value to the Medical Department. By 1899, the Army employed with 1,563 contract nurses, who served in the typhoid-infested hospitals of the United States and in the malarial climates of Cuba, Puerto Rico, and the Philippines. A total of 140 nurses contracted typhoid, 12 died from typhoid and one died from yellow fever. Discussing their work, Sternberg commented that "American women may well feel proud of the record made by these nurses in 1898-1899, for every medical officer with whom they served has testified to their intelligence and skill, their earnestness, devotion, and self-sacrifice."[56]

With the use of female nurses as one of the few medical success stories of the Spanish-American War, the Army wanted to incorporate them as a permanent part of the Medical Department. In February 1901, Congress authorized the Army Nurse Corps. Its first members were the women who had served as contract nurses in the Spanish-American War. Until World War I, the Nurse Corps never exceeded 220 members. Nurses served only in general hospitals until World War I.[57]

Nursing in the Navy began within a few years after the beginning of the Army Nurse Corps. The Navy surgeon general had recommended the introduction of women nurses as early as 1902, but Congress had ignored his requests. In 1907, he reiterated his recommendation with these words:

> That women nurses are by natural endowment and special aptitude superior to male nurses for much of the duty required in the care of sick and injured men is generally admitted; that their employment is compatible and would not conflict with the conditions arising from the military character of our institutions may be inferred from the experience of the Army, which acknowledges their work as deserving of the warmest praise; and we have only to look back upon their record of splendid services in modern wars to be convinced of their adaptability to service conditions and of their efficiency in institutions under military control. Indeed their importance in military service, as well as in civil life, has been amply and conclusively demonstrated and is now firmly established.

This time Congress accepted his recommendations and in 1908, the Navy Nurse Corps was born. The first nurses entered the Norfolk Hospital in April 1909.[58]

Like their Army counterparts, Navy nurses at first worked primarily in the larger hospitals, while men performed similar duties at sea. Navy nurses did make one particularly noteworthy contribution to medical care with their service in island possessions. At the beginning of the twentieth century, the Navy administered the newly acquired territories of Guam, American Samoa,

and the Virgin Islands. Navy nurses assigned to these islands taught native women essential hygiene practices that led to improved health in the territories.[59]

After the United States entered World War I, the Army Nurse Corps grew to 21,480. Of that number, about half were sent overseas, where most served in base hospitals. Other nurses served in evacuation or mobile hospitals, or ambulance trains, and a few served in field hospitals. Conditions for these nurses varied from challenging to quite arduous. Three nurses received a Distinguished Service Cross, 24 the Distinguished Service Medal, and 28 the Croix de Guerre. Those who remained in the United States performed difficult and important work, especially when the influenza epidemic made any hospital work dangerous.[60]

After the war, Congress provided "relative rank" for members of the Nurse Corps, with the superintendent receiving relative rank of major, and subordinate nurses being the equivalent of captain through second lieutenant. They did not receive commissions, nor all of the privileges of commissioned officers. They did receive the right to wear insignia of rank and other privileges of officers, such as professional education in nursing. In 1926, Congress authorized retirement for Army and Navy nurses. The construction of numerous nurses barracks or dormitories at Army posts and near naval hospitals during the inter-war period indicates that female nurses were becoming a standard component of the military medical services.[61]

The Army Medical Specialist Corps also began during World War I. During that war, the Army hired women as dietitians, physical therapists, and occupational therapists. They worked as civilians until December 1942, when Congress authorized relative rank for women serving in these specialties. In 1947, Congress created the Women's Medical Specialist Corps, and authorized regular commissions for dietitians, physical therapists, and occupational therapists. The branch was changed to the Army Medical Specialist Corps in 1955.[62]

NOTES

1. Mary C. Gillett, *The Army Medical Department 1775-1818* (Washington: Government Printing Office, 1981); 1-22; Mary C. Gillett, *The Army Medical Department 1818-1865* (Washington: Government Printing Office, 1987), 10-22.

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CHAPTER 4
PLANNING AND ARCHITECTURE

Introduction

Military planning and architecture illustrates the evolution of military philosophy, goals, and objectives, constructed within budget constraints. Military construction is linked directly to national defense and to the evolution of the United States into a world power. The facilities required to meet military goals included coastal fortifications, frontier garrisons, shipyards, arsenals, armories, training facilities, testing and research facilities, hospitals, and airfields. In general, military construction reflected simpler versions of contemporary architectural design, built and designed by talented military and civilian engineers and architects. Military installations were self-contained communities, thus their site designs frequently were the result of large-scale planning efforts that illustrate contemporary planning theories. Installations that developed over a comparatively short period often display unified overall planning and architecture. However, many military installations grew over time, and reflect the more diverse influences that would affect any community that evolved over an extended period of time.

Coastal Fortifications

Army installations were constructed in response to defensive goals. In general, construction responsibilities in the Army were divided between the Corps of Engineers and the Quartermaster Department. The Corps of Engineers was in charge of engineering structures, such as seacoast fortifications, canals, bridges, and harbor and river improvements. The Corps of Engineers also was charged with construction at the United States Military Academy at West Point, which was established in 1802, in part, to train engineers for public service. The Corps of Engineers constructed seacoast fortifications to defend major harbors and naval shipyards. Between 1816 and 1860, the Army undertook an ambitious program to construct masonry fortifications to defend the U.S. coast. In some cases, fortifications required supporting structures such as officer housing and storage. For example, Building 1 at Ft. Monroe, Virginia was constructed in 1819 to house the chief engineer in charge of the fortifications. By the time of Civil War, weapons technology made the masonry seacoast fortification obsolete. One of the last masonry fortifications constructed was Ft. Totten, started in 1862 and discontinued in 1867. (For more information on coastal fortifications, see sections on fortifications and coastal defense in Part I: Chapters 1, 2, and 3, and in Part II: Chapter 5, "Technology.")

Early Frontier Posts, 1790 - 1875

Along with coastal defense, the other primary mission of the Army was securing the interior of the nation and its borders. To accomplish this mission, the Army established a series of temporary posts in the country's ever-expanding frontier areas. The Quartermaster Department was assigned the responsibility of providing supplies. After 1818, Quartermaster responsibilities also included construction of temporary Army posts. Temporary posts included, for the most part, small frontier garrisons established to guard major transportation routes and contain Indian tribes. For most of the nineteenth century, the Army frequently established and moved its encampments within the frontier region, in response to particular conflicts with Native Americans. Frontier posts could exist for less than one year or for the duration of the Indian Wars. Posts could be as small as one or two companies, but they were seldom of any significant size.

The early posts of the Old Northwest (now Ohio, Indiana, and Wisconsin) consisted of an encircling wooden palisade wall, corner blockhouses, living quarters, and storage and shop buildings (Figure II-4). After the frontier moved west of the Mississippi, the spatial arrangement of frontier posts evolved. In some cases, wooden palisades encircled western posts, but gradually the palisade disappeared as a protective fortification. The parade ground became more pronounced as the center of the frontier post. The barracks, officers' housing, and administrative buildings surrounded and faced the parade ground. Various service areas were located apart from the central parade ground: an infirmary or hospital; guardhouse; agricultural fields; and, shops. Stables for cavalry troops were located close to the barracks, while corrals and quartermaster storage facilities were located apart from main parade ground area. A typical example of this frontier post plan is Ft. Leavenworth (Figure II-5).

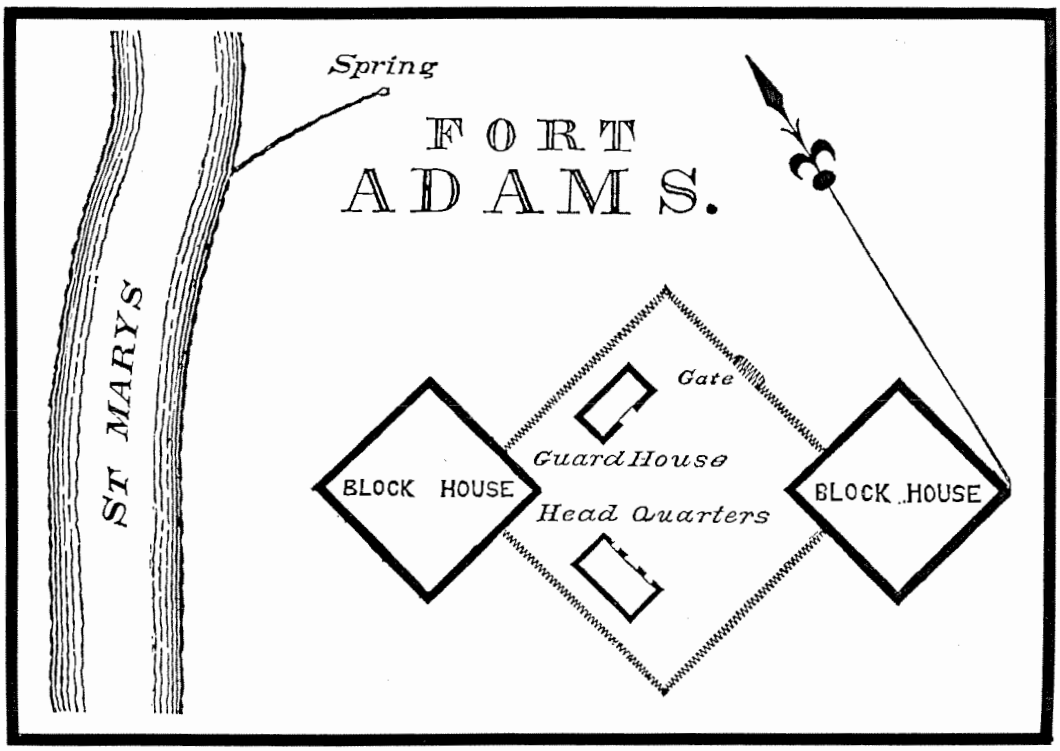
While no official instructions on how to organize an Army post have been located to date, an 1860 proposal suggested the arrangement of a garrison for four companies (Figure II-6):

> 31. Plan of a Garrison. Officers' quarters, chaplain's quarters, and officers' mess on one line, facing a parade ground open at both ends and varying in breadth at different posts, according to the ground and other circumstances, from 250 to 400 feet; all other buildings on the other side from the officers' line, and in positions to be presently described. On that side an avenue 220 feet wide extending outward perpendicularly from the parade ground, will separate the troops from the supplying departments; another avenue 200 feet wide, parallel to the first, and 300 feet from it, will separate the supplying departments from the sutler's establishment and the hospital ground...[1]

The unofficial 1860 regulations, which were privately published in 1861, also included plans, drawings, and cost estimates for standardized construction of barracks, quarters, hospital, storehouses, offices, stables, guardhouse, and chapel (Figure II-7). The proposed plans were adaptable to various construction materials including frame, stone, brick, earth, or logs, depending on climate, cost of construction, and required durability. The plans were drawn simply so that construction could be performed by troop labor, though some skilled labor, such as a carpenter, might be required.[2]

The 1860 standard plans represented a conscious effort to standardize construction on Army frontier posts. Although never officially adopted, the proposed layouts and building plans depict examples of Army construction identified before 1860. As such, the plans do not illustrate a new trend in Army construction, but rather an effort to codify the desired existing practices. The 1860 proposed post plan was cited again in *Circular No. 4, A Report on Barracks and Hospitals with Descriptions of Military Posts*, published in 1870. An 1876 Army publication, *Outline Descriptions of the Posts in the Military Division of the Missouri*, contains sketch maps of the posts within the plains regions. Despite individual variations, each post conformed to the general pattern of building arrangements discussed above.[3]

The appeal of standardization of post construction is a recurring theme in Army construction; through standardization, the Army sought to control construction costs and improve living conditions. The organized post of sturdy buildings depicted in the 1860 unofficial regulations was a far cry from the conditions at many forts, particularly those in the frontier. In 1872, Quartermaster General Montgomery C. Meigs proposed a set of standardized plans, including barracks, officers' quarters, guard house, commissary storehouse, and bake house (Figure II-7)[4]. Meigs also began a program to record post layouts and plans of extant buildings to produce an inventory of real property under Quartermaster control. Criticisms from the Surgeon General spurred the real estate inventory after the Surgeon General condemned general troop living conditions in his assessments of the hygiene of barracks and hospitals at military posts.[5] These



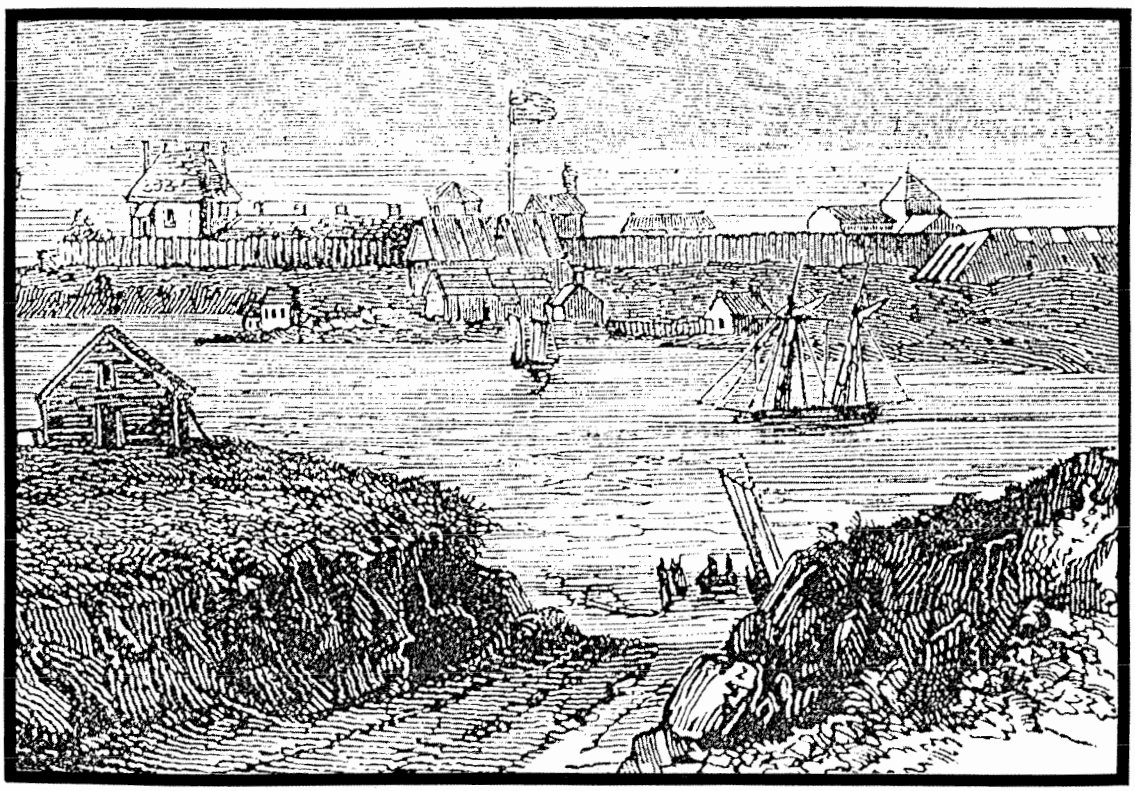


Figure II-4. Plan of Ft. Adams, Ohio, drawn by b. Van Cleve in 1794, *above*. (From Roberts, *Encyclopedia of Historic Forts*, 1988). Artist's rendering of Ft. Niagara, New York, *below*. (Courtesy National Archives)

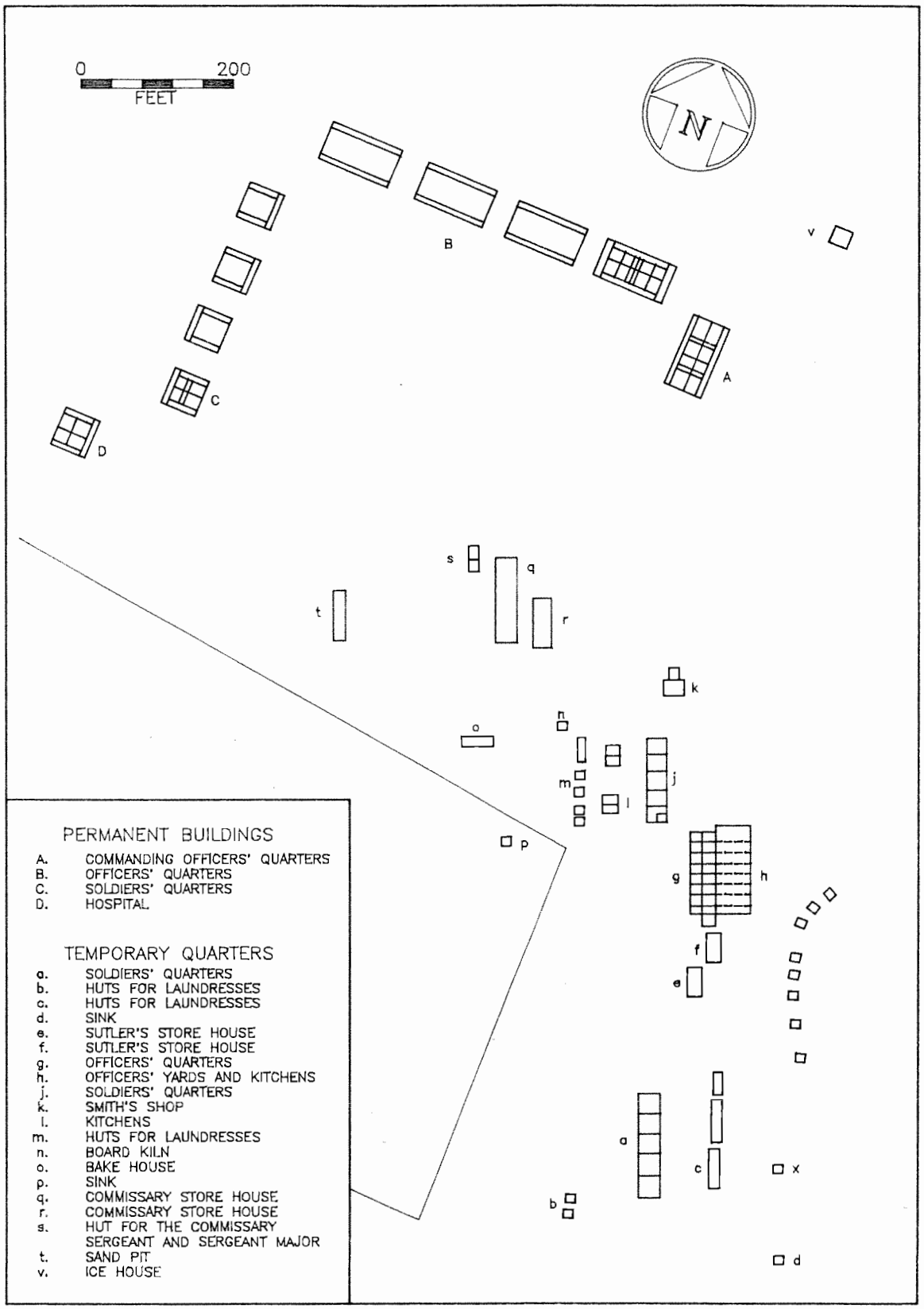


Figure II-5. Plan of Cantonment Leavenworth, 1828. (From Edward DeZurko, "A Report and Remarks on Cantonment Leavenworth," 1947)

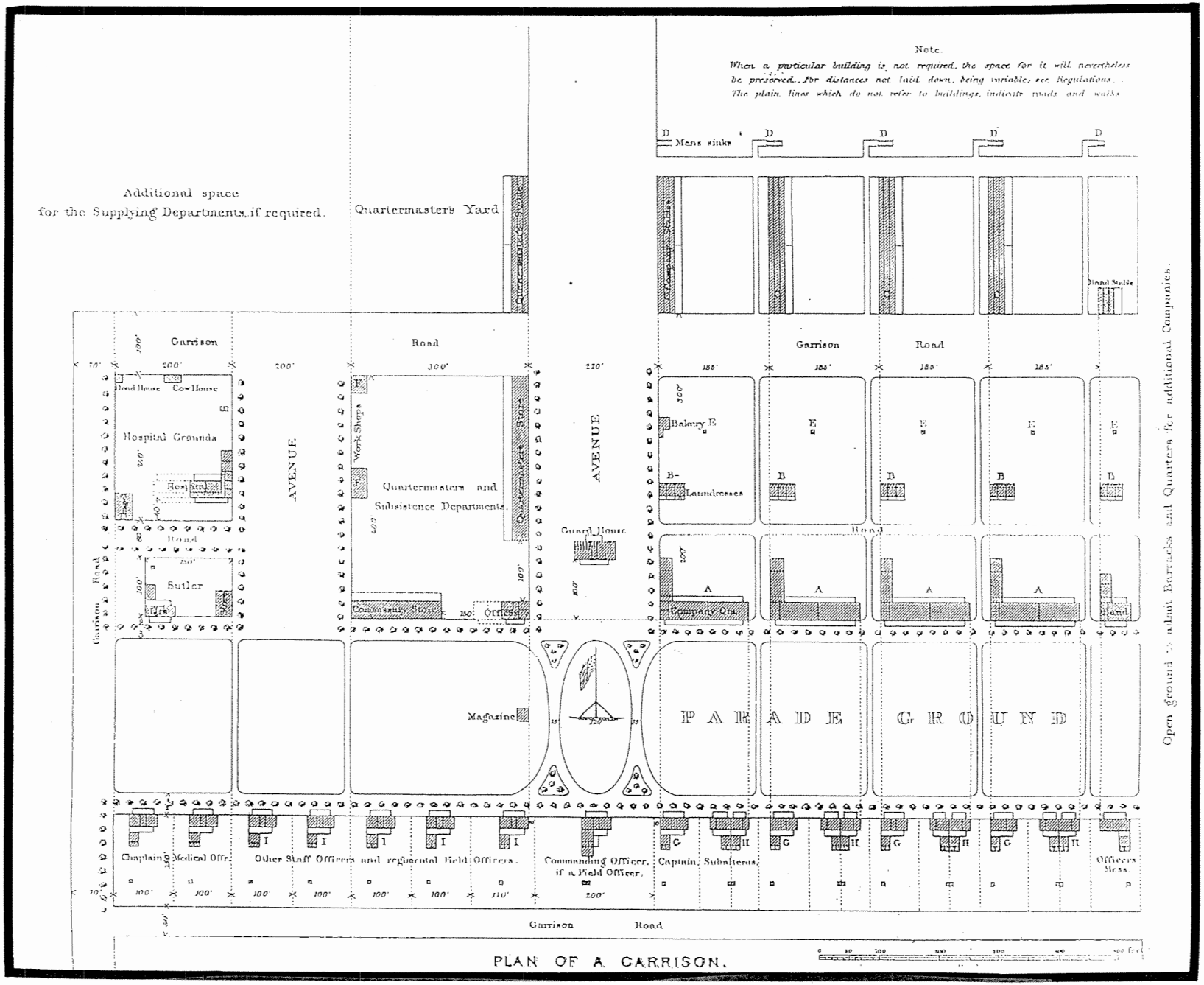


Figure II-6. 1860 Proposed plan of garrison. (From U.S. War Department, *Regulations Concerning Barracks and Quarters for the Army of the United States, 1860* [Washington, D.C.: George Bowman, Printer, 1861])

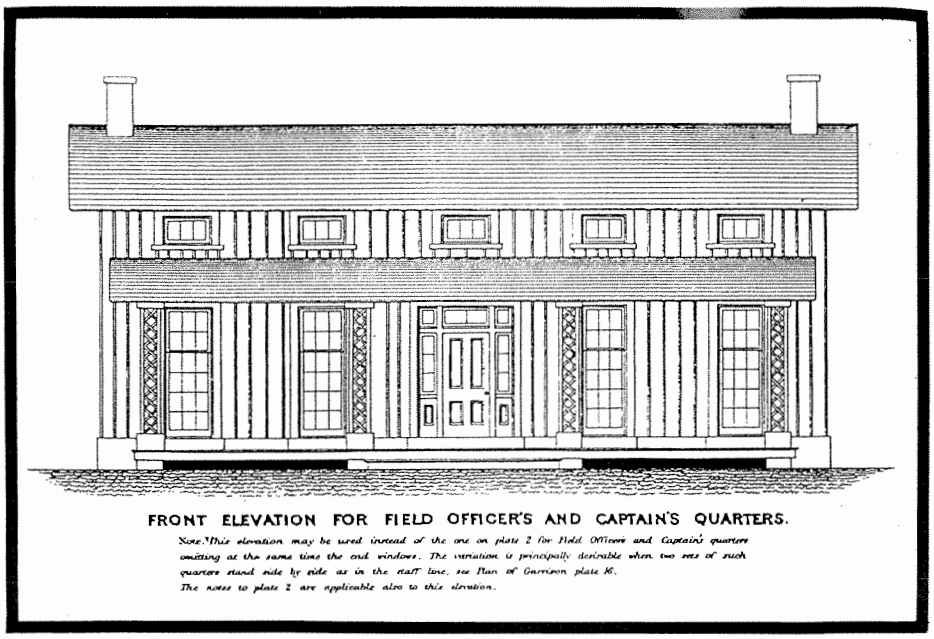


Figure II-7. Proposed plans for field officers' housing, *above*. (From U.S. War Department, *Regulations Concerning Barracks and Quarters for the Army of the United States, 1860* [Washington, D.C.: George Bowman, Printer, 1861]). Company officers' housing proposed by Quartermaster General Montgomery C. Meigs, *below*. (From War Department, *Annual Report* [1872]).

efforts laid the ground work for the consolidation of posts and widespread standardized construction under the Office of the Quartermaster General that accompanied the end of the Indian Wars and closing of the American frontier at the end of the nineteenth century.

Industrial Eclecticism: Ordnance Facilities and Shipyards, 1790 - 1875

Starting in the early nineteenth century, the U.S. military established industrial facilities to meet special military requirements. Both the Navy and the Army built facilities to develop and produce ordnance, while the Navy also constructed shipyards to construct and repair ships. The planning of industrial facilities was based on the functional requirements of specific industrial processes. The architecture of military industrial facilities is similar to that of their civilian counterparts. Some facilities had unadorned, masonry structures; others display finely-crafted examples of nineteenth-century revival aesthetics, where manufacturing was concealed behind facades of columns and porticos. Mass-produced cast and wrought iron was introduced into American commercial and industrial construction during the 1840s, and also was used for military construction of the era.

Army Ordnance Department

The Ordnance Department, established in 1812, constructed arsenals and armories to produce and store weapons, ammunition, and other material. The ordnance facility was organized around technological and production processes; industrial buildings were located to facilitate production stages in an organized manner. Other buildings such as quarters, administration, and supply buildings supported the central industrial core. Housing was set apart from the industrial core.

Arsenal construction was decentralized and followed no standardized plans. Commanding officers either possessed the talent to design industrial, residential, and support buildings needed at arsenals and armories, or sought advice from fellow ordnance officers. Because of the decentralized construction program of the Ordnance Department, each ordnance facility tended to have a unique appearance. Ordnance Department personnel often adapted contemporary architectural styles to their construction projects, such as the Greek Revival officer's quarters constructed in 1841 - 1842 at Watervliet Arsenal, New York. In some cases, they turned to new building technologies, such as the cast and wrought iron storehouse ordered from Architectural Iron Works of New York City in 1859 for Watervliet Arsenal.[6]

Thomas J. Rodman was one of the talented designers and planners in the Ordnance Department. He planned and oversaw construction of two ordnance facilities: Watertown Arsenal, Massachusetts, and Rock Island Arsenal, Illinois. Rodman arranged the industrial buildings to facilitate industrial production. At Rock Island Arsenal, Rodman designed a symmetrical complex of monumental stone shop and storehouse buildings with classically-inspired architectural designs (Figure II-8). In his design for a commanding officer's quarters, he constructed an Italianate villa, now one of the largest dwellings in the Army's current building inventory.[7]

Navy Yards

Navy installations during the nineteenth century consisted primarily of yards along the Atlantic, and smaller yards in the Gulf of Mexico and Pacific. The Navy used these yards to build, repair, and resupply ships within its fleet. Nineteenth-century shipyards display both common elements of design, based on their similar functions, and great individuality, due to the Navy's

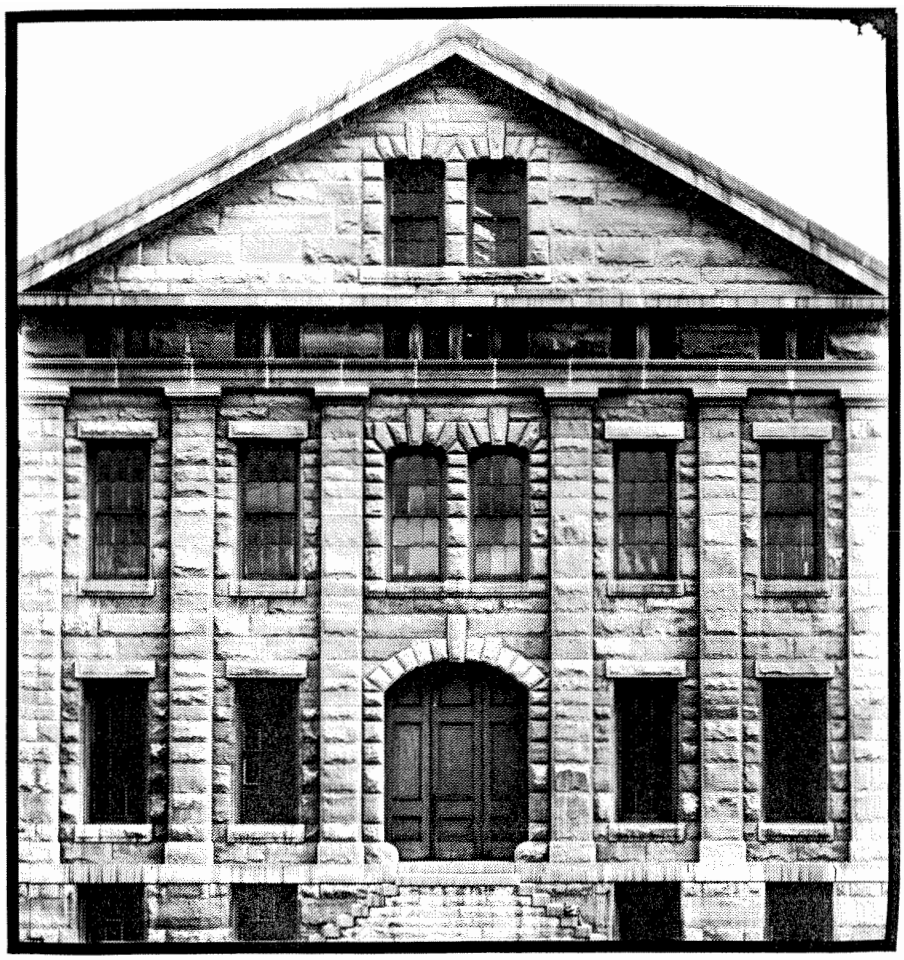
decentralized construction program. Unlike the Army's frontier posts, most naval facilities were built as permanent facilities. Therefore, they possess a range of buildings erected over long periods of time that exemplify the nineteenth-century traditions of classically-inspired public and industrial architecture. Due to this desire for permanence and a public presence, the Navy turned to professional architects and engineers as its construction programs developed.

Navy engineers planned yards to facilitate ship construction and repair. The Navy arranged its yards by their function: ship repair and construction, supply and storage, administration, officers' housing, and marine barracks. Activities that directly supported ship construction and repair were located along the waterfront. Storage facilities and support buildings were located behind the waterfront buildings. A rectilinear layout characterized the arrangement of industrial buildings and waterfront structures at navy yards. The administration building and officers quarters were located adjacent to the yard buildings. The Marine Corps barracks and officers' housing were located on a marine reservation near the yard.

The industrial buildings at naval shipyards were of permanent, masonry, generally brick, construction. The purpose of the buildings was functional; their appearance, utilitarian (Figure II-9). Little external differentiation existed between types of buildings; for example, a mast house was similar in construction and appearance to a storehouse. Large, undivided space characterized the interiors. The Navy was able to convert the early industrial buildings to new use; for example, at the Washington Navy Yard in Washington, D.C., the Navy transformed shipbuilding facilities into weapons production and testing facilities beginning in the 1820s. Industrial buildings at shipyards included: a smithery, rigging loft, workshops, mast house, boat shop, cooper's shop, and a variety of storehouses for construction and rigging materials. General storehouses contained ship's supplies and ammunition, while other shipyard storehouses contained raw materials and finished products.

The Navy built relatively few administrative or residential structures at its yards; a single administration building and a handful of officer's quarters proved sufficient for the limited needs of the early yards. The nineteenth-century administration buildings and residences at Navy yards reflect the architectural trends of their time, and are best understood within the context of popular architectural styles of the period. The commandant's house at the Marine Corps Barracks at the Washington Navy Yard is an example of the Federal style. Built between 1801 and 1806, its design is attributed to George Hadfield, a British architect who supervised part of the construction of the U.S. Capital and influenced the neo-classical appearance of Washington, D.C. Later modifications in 1891 added a mansard roof to provide more space and update the design of the quarters. At Portsmouth Navy Yard, local joiner John Locke built Quarters A (1818), an example of wood frame, Greek Revival architectural design (Figure II-10). Italianate officers' quarters were constructed during the 1870s at Pensacola Navy Yard, Florida. The Mare Island and Portsmouth Navy Yard administration buildings, constructed in 1855 and 1865 respectively, are examples of eclectic, mid-century classically-inspired buildings without specific, historical precedents.

Ship houses and dry docks at Navy yards represented engineering feats of their day. Ship houses were large frame structures that enclosed the stocks and protected workmen from the weather. The first ship house was constructed in 1814 at the Portsmouth Navy Yard, New Hampshire, to protect workers from the New England winters. The dry dock constituted a major feature of each navy yard. These were either excavated and were given thick granite siding to offset the upward water pressure, or were floating dry docks which were cheaper, but less durable than the excavated dry docks. In either case, they were used to scrape and repair ship hulls. After the completion of the first masonry dry docks at the Navy yards in Boston and Norfolk, the construction of dry docks at the other navy yards followed.



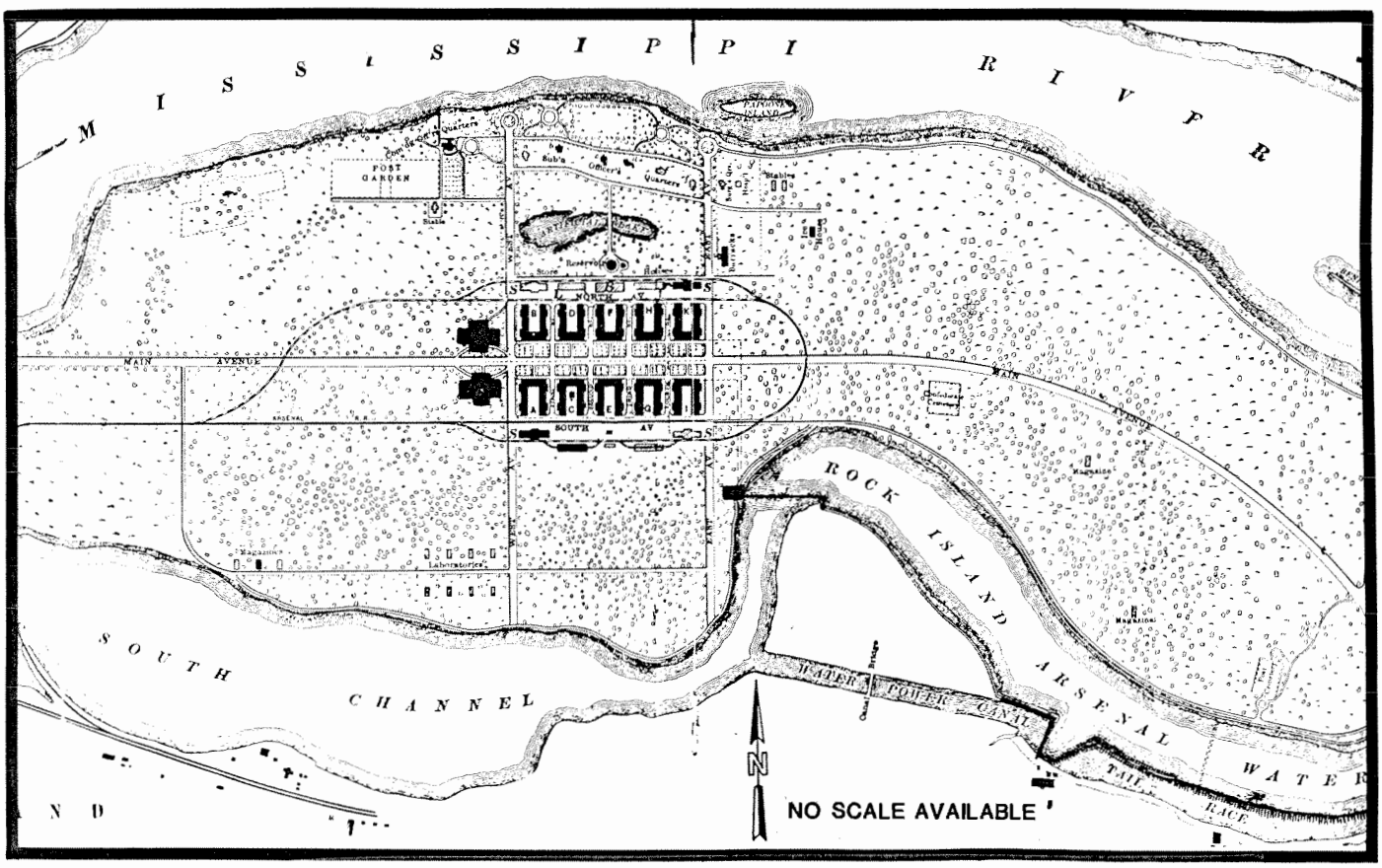


Figure II-8. Rodman's plan for Rock Island Arsenal ca. 1865, *below*. Front facade of shop H, completed ca. 1880, *above*.

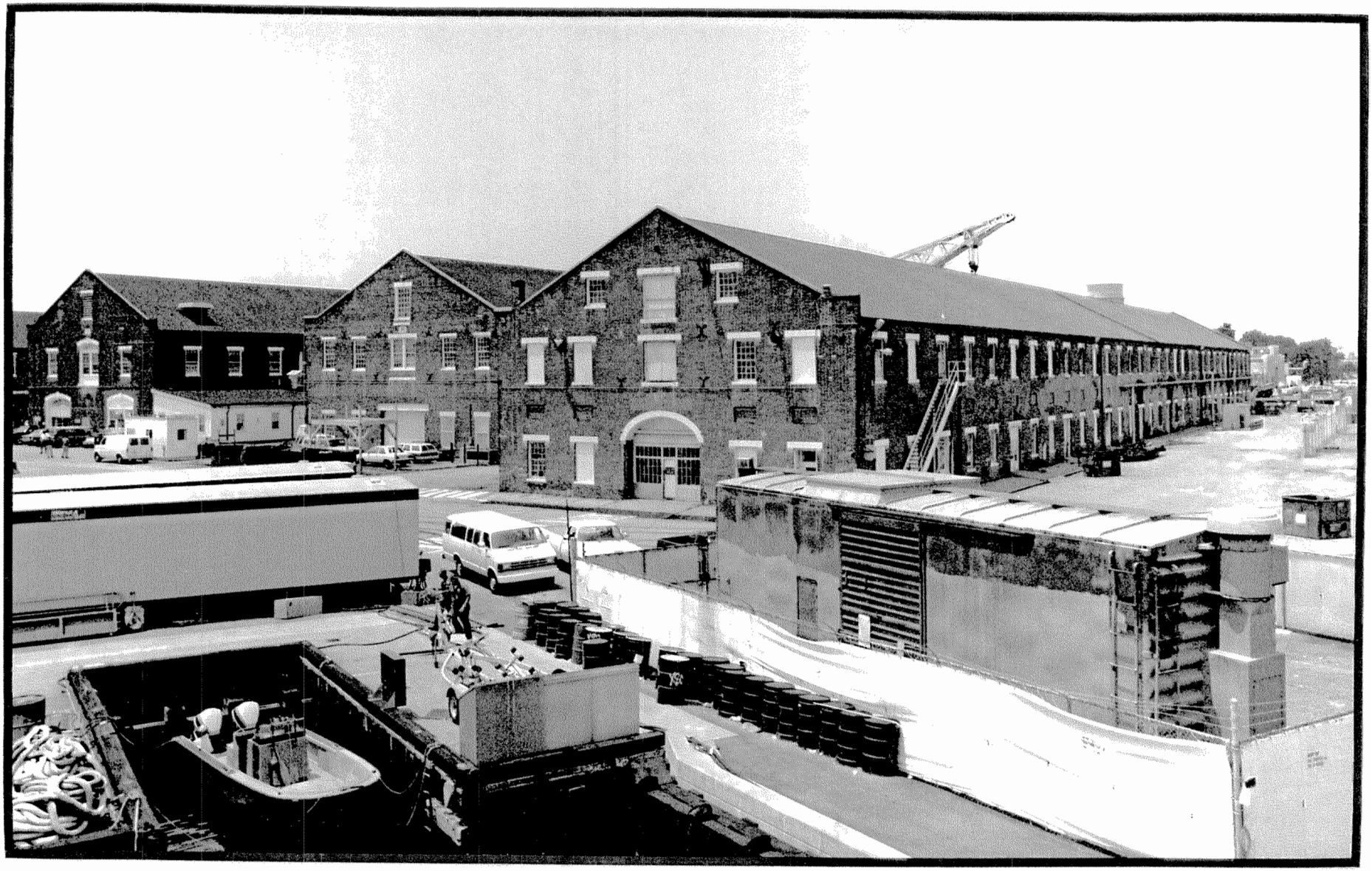


Figure II-9. Buildings 28, 29, and 30 at Norfolk Navy Yard, Virginia, originally constructed between 1832 and 1836, and rebuilt after the Civil War. (Courtesy of U.S. Navy)

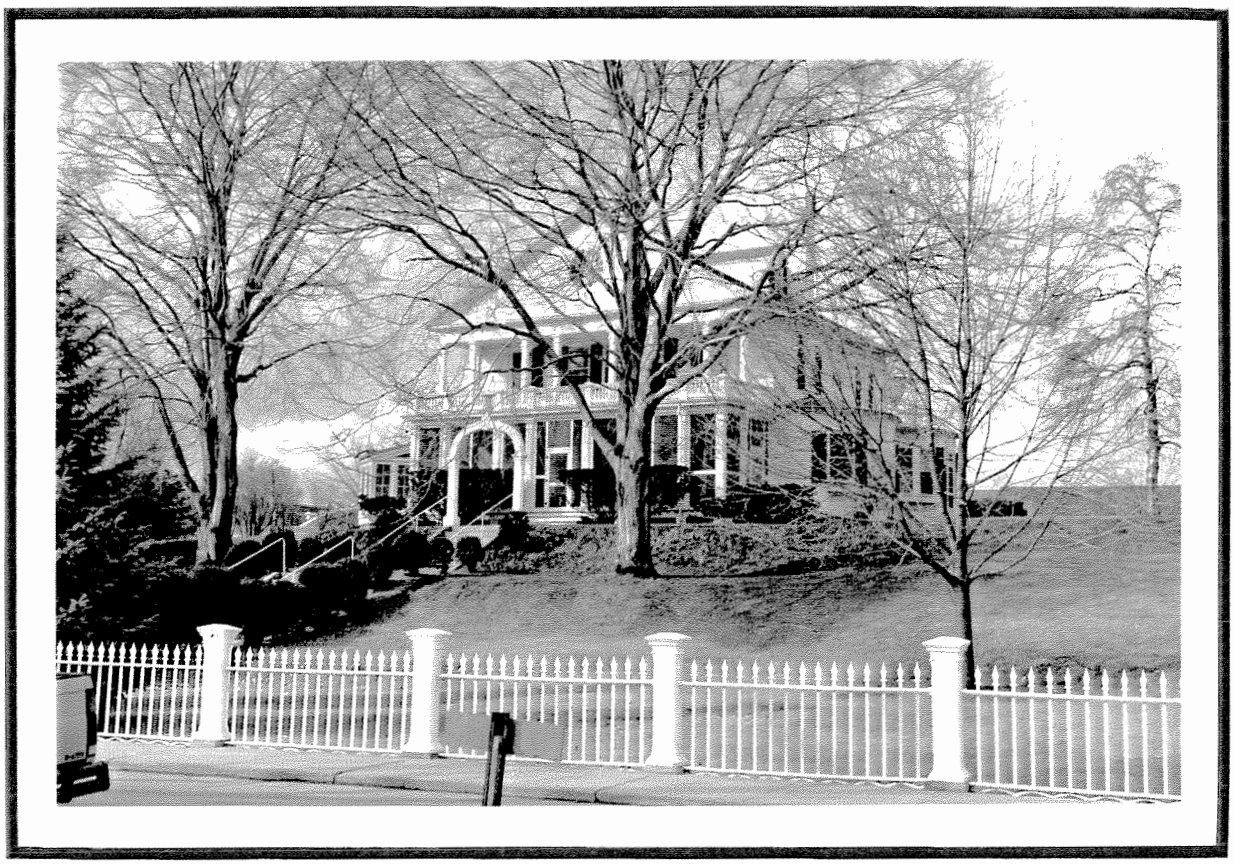


Figure II-10. Example of early commander's quarters at Navy yards: Quarters A, built in 1818, Portsmouth Navy Yard. (Courtesy of U.S. Navy)

The Navy administered shipyard construction at both the local shipyard and at the Navy Department levels. The Navy Department in Washington, D.C., requested funding for individual shipyard projects directly from Congress. After Congress allocated the funds, the naval agent at the shipyard advertised for building designs and plans from local suppliers. The naval agent then submitted the plans and estimates to the Secretary of the Navy or, after 1815, the Board of Naval Commissioners, for review and approval. Upon approval or revision, the local naval agent advertised for construction materials and labor.[8] This administrative system allowed a considerable degree of latitude for building designs at Navy yards.

As construction needs at Navy yards changed, the Navy Department instituted a planning program to anticipate construction needs and monitor budgets. In 1827, the Navy required the preparation of master plans for each shipyard. All buildings were numbered to record existing shipyard conditions and planned future improvements. Loammi Baldwin (1780-1838), one of the first American civil engineers, assisted in preparing master plans, which were completed in 1830. Master plans were kept at the yards and at the Navy Department office. These plans facilitated discussion of improvements in correspondence between personnel at the yards and at the Navy Department.[9]

Construction at early naval shipyards employed the talents of many construction professionals, including carpenters, masons, civil engineers, and architects. The Navy generally contracted with local civilians. Some of the most noted early American architects and engineers worked on Navy yards. Benjamin Henry Latrobe (1764-1820) contributed early designs for the Washington Navy Yard in Washington, D.C., and prepared a master plan for the yard in 1805. From 1827 to 1834, Loammi Baldwin, a Boston native, designed and oversaw the construction of the first masonry dry docks in the United States at the Charlestown (Boston, Massachusetts) and Gosport (Norfolk, Virginia) shipyards. Baldwin was founder of the American Civil Engineering Society, and trained many engineers that later served the Navy. Noted Boston architect Alexander Parris (1780-1852) was the on-site engineer in charge of dry dock construction at the Charlestown Navy Yard. Parris was a salaried employee at the Charlestown Navy Yard between 1834 and 1842 as "Engineer and Superintendent of the Works." In 1835, Parris tried to obtain a permanent position at the Charlestown Navy Yard, but the Board of Navy Commissioners replied that there was no law authorizing a permanent appointment; the Navy employed civil engineers only as needed. Parris later worked at the Portsmouth Navy Yard.[10]

The Navy Department in Washington reviewed building designs for each Navy yard and controlled construction costs. Sometimes, the Navy Department required that existing building plans be used for a particular project. When the Boston Navy Yard required a new smithery, the yard commandant chose the site, but the Secretary of the Navy sent the plans, using a smithery constructed at the Brooklyn Navy Yard as a model.[11]

In 1842, the Navy established the Bureau of Yards and Docks, which became responsible for "the navy yards proper, the docks and wharves thereof, all buildings therein...including magazines and hospital buildings." Under the Bureau of Yards and Docks, the Navy established the Office of Civil Engineer in Washington, D.C., and authorized civil engineers or engineering experts at each shipyard to design buildings necessary for ship construction.[12]

In September 1842, the Secretary of the Navy appointed William P.S. Sanger (1809-1890) the Bureau of Yards and Docks' first civil engineer. Sanger had served as Baldwin's principal assistant to construct the dry dock at Norfolk Navy Yard, and in 1836, he served as civil engineer for the Board of Navy Commissioners. After his 1842 appointment, Sanger supervised and inspected plans and estimates for material and labor for buildings, hospitals and magazines and other improvements at the yards and stations performed by yard employees. Only a small part of the construction work was done under contract.[13]

By 1853, each shipyard had a civil engineer responsible for construction of all buildings, docks, and wharves; supervision of all construction masters and workmen compliance with Bureau of Yards and Docks' instructions; preparation of plans and cost estimates for construction; and, procurement and management of all construction materials required. In March 1867, Congress passed legislation authorizing commissions for the Navy's civil engineers and officially established the Civil Engineer Corps (CEC). The President was authorized to appoint ten civilian civil engineers as Navy personnel. In 1871, Congress accorded Navy civil engineers relative rank and precedence with line officers, and, ten years later, authorized them to wear the uniform of officers of the line.[14]

Permanent positions for civil engineers allowed for the creation of a pool of civil engineers that were rotated among shipyards. The career of Calvin Brown provides an example of the life of a naval civil engineer. In 1834, Brown began his study of civil engineering under Loammi Baldwin in Boston. Between 1841 to 1846, he served as the civil engineer at Portsmouth Navy Yard, New Hampshire. After a stint working for a railroad, Brown was appointed as civil engineer to Norfolk Navy Yard. Between 1862 and 1864, Brown served as the civil engineer at Mare Island Navy Yard, California. After a few years in private practice, he was reappointed as civil engineer at Mare Island in 1869, where he served until 1881.[15]

One example of the Navy's planning process was the relocation of the Philadelphia Naval Shipyard to League Island in Pennsylvania between 1871 and 1874. A board of naval civil engineers studied the site and formed a master plan for the new installation. The board reviewed the geography of the site, took soundings, reviewed available plans of yards in the United States, England, France, and other countries, and requested comments from individual Bureau chiefs. From the compiled information, the engineers used a grid pattern to lay out the yard, select locations for necessary shops, and allocate sites for future expansion.[16] By 1874, the new shipyard had five buildings: one quarters, two storehouses, a boiler and engine house, and a shop. The buildings reflected contemporary architectural trends. Quarters A, an Italianate villa, was constructed for the chief engineer. Building 4, the yard administration building, was constructed of brick, with stone quoins at the corners, and was capped with a mansard roof, and reflected the French Second Empire style popular for public architecture during the 1870s (Figure II-11).

Consolidation and Modernization

Mid-nineteenth century American architecture was marked by robust individualism and eclectic design. The most flamboyant Second Empire, Romanesque, and Italianate villas designs were usually beyond constrained post-Civil War military budgets, with a few notable exceptions, such as Rodman's designs for the Rock Island Arsenal (see above). However, elements of the prevalent eclecticism may be found in the Gothic Revival gable-trim of quarters at Ft. Douglas, Utah; the varied quarters and administration buildings at many Navy yards; and the Romanesque-inspired tower of Ft. Sheridan, Illinois.

Between 1885 and 1915, American architecture underwent a move towards consolidation and harmony through the use of formal plans and classically-inspired architecture. The growing prosperity and prominence of the young nation demanded a suitable architectural expression. The World's Columbian Exposition in Chicago in 1893 greatly influenced American architecture and city planning. The exposition was a product of the Beaux Arts approach to design, which emphasized monumentality, symmetry, classical ornamentation, and hierarchy in support of civic institutions.[17]

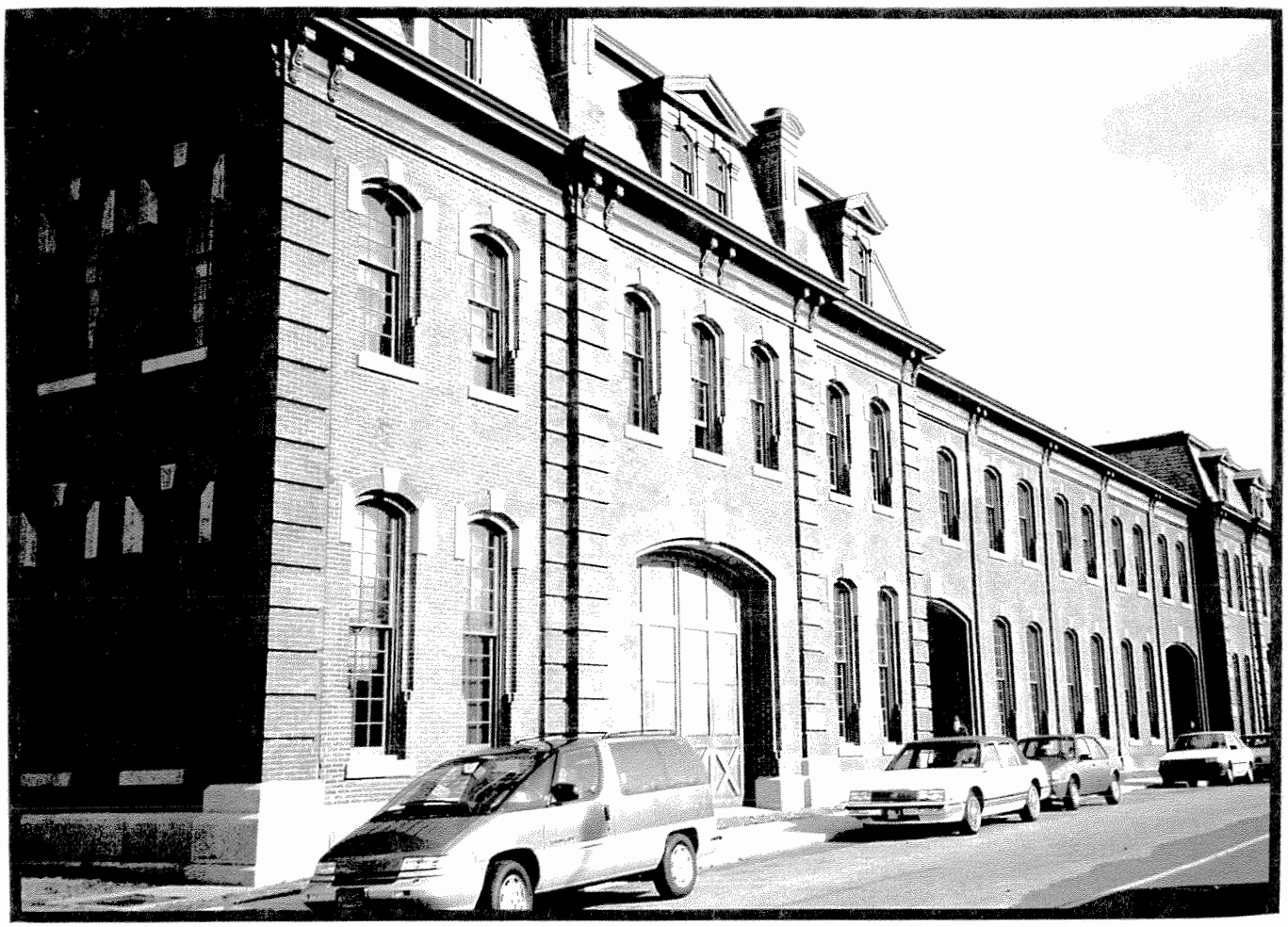


Figure II-11. Philadelphia Navy Yard administration building (Bldg. 4), constructed in 1874.

Late nineteenth-century military architecture reflected both trends, but clearly moved in the direction of ordered classicism. Between 1880 and 1910, the Army and the Navy redefined their roles and responded to technological advances in warfare. Military personnel experienced heightened professional prestige; military education received greater attention and military educational institutions were expanded. As the nineteenth century came to a close, the military establishment reflected the increased national awareness of the United States as a world power. The military installations established and expanded during this time reflected these trends. Military construction illustrated a dramatic improvement in living conditions for military personnel, and an effort on the part of military planners to adapt contemporary civilian architectural styles and planning practices to installations. The development of the architectural profession and the dramatic use of Beaux-Arts planning ideals as exhibited at the Columbia Exposition had an appreciable influence on planning and design at military installations.

Army Consolidation of Posts

Army construction recovered first from the curtailed congressional funding appropriations following the Civil War. After about 1878, funding appropriations gradually increased through a combination of special projects, new construction, and needed maintenance. Three events allowed the Army to restructure the location of its installations: the end of the Indian Wars, the settlement of the frontier, and the development of the railroad system that allowed troops and supplies to move more easily across great distances.

The Army began to consolidate troops into larger regional installations near railroads and abandon small temporary frontier posts. In general, the locations of the new installations reflected regional military goals: defense of the territories in the Southwest and Northern Plains: administration of the six geographical departments: and establishment of specialized training facilities. During the 1880s and 1890s, new Army construction projects included: Ft. Assiniboine, Montana; Ft. Huachuca, Arizona; Headquarters in San Antonio (later Ft. Sam Houston) and Ft. Bliss, Texas; Ft. Snelling, Minnesota; Ft. Russell, Wyoming; Forts Leavenworth and Riley, Kansas; Ft. McPherson, Georgia; and, Ft. Sheridan, Illinois.[18]

The new, larger, and permanent installations required a higher level of planning, construction, and design. The Quartermaster Department addressed new issues such as improving living standards, especially at installations located near urban areas. At posts in relatively isolated locations in the Southwest and Northern Plains, the Army continued construction that followed the 1870s standardized plans. At headquarters, training, and consolidated regional installations, building designs became more sophisticated, and efforts were made to construct buildings of greater architectural stature to reflect increased Army prestige. The Quartermaster Department incorporated concerns about hygiene into designs for barracks and hospitals. Integrated water, sewage, and heating systems were instituted for Army posts for the first time. In addition, the Army began to provide family housing for hospital stewards and non-commissioned officers; previously, detached houses or duplexes were built only for officers.

The process of Army construction also changed. Constructing Quartermasters no longer oversaw actual building construction using troop labor, but adopted the role of contracting officers, monitoring procurement of construction materials and labor within appropriated funding budgets. Civilian architects were hired to design many of the new installations located near urban areas. Architects designed buildings in simplified versions of the eclectic architectural styles then nationally popular: Italianate, Romanesque Revival, and Queen Anne. Civilian architects also influenced overall installation planning. At Ft. Sheridan, Illinois, the installation incorporated curving residential streets similar to early suburbs. Some of the architects identified working at Army posts during the 1880s and 1890s include William Goding at Ft. Riley, Kansas; Gustav

Freibus at Ft. McPherson, Georgia; Holabird and Roche at Ft. Sheridan, Illinois; E.T. Carr at Ft. Leavenworth, Kansas; F.J. Grodavent at Ft. Logan, Colorado; and, Alfred Giles at Ft. Sam Houston, Texas (Figure II-12).

Ft. Riley provides an excellent example of an Army post that was substantially rebuilt during the late 1880s and early 1890s. Ft. Riley had been a frontier cavalry post since 1853 (see Figure I-1). Its original purposes, to protect trails to New Mexico and Colorado and to preserve order among feuding settlers, became less relevant as eastern Kansas developed. In 1885, the War Department decided to renovate the installation, and, in 1887, Congress authorized a School of Application for Cavalry and Light Artillery at Ft. Riley.

The Army assigned Captain George E. Pond to Ft. Riley to supervise construction in 1885. At first, Pond was assigned to duties as the post quartermaster, but, in 1887, his job title changed to Constructing Quartermaster, allowing him to devote his full attention to rebuilding the post. Pond was assisted by a young architect, William Goding.[19]

Captain Pond was faced with the construction of two separate posts, one for cavalry and one for artillery. Each section of the post was a separate administrative unit and each had its own parade ground (Figure II-13). This was a common way to expand existing Army installations, particularly if different missions were stationed at the same installation. Pond's site design displayed a combination of formal and informal principles of planning. The land that surrounded the cavalry parade field featured two axes. At three of the four axes terminals, an important feature marked the terminus. The stables were located south of the cavalry parade ground in fan-like patterns. The artillery post employed a single axis through the parade ground. The officers' quarters lined a semi-circle at the upper end of the parade ground, with barracks and administration buildings at the lower end. Along the periphery of the installation, Pond took advantage of the terrain to create a more informal landscape for the non-commissioned officers' housing. Warehouses, stables, utilities, and other supporting buildings lined the banks of the Kansas River.[20]

Installation planning for Ft. Riley also included such practical matters as water, sewage, and heating. An innovation for Ft. Riley was a central steam-heating plant. Four miles of pipe were used to send steam throughout the post. This plant captured and recondensed the steam to avoid a build-up of calcium in the boilers. The post design also utilized the sloping terrain in order to create a sewer system that emptied into the Kansas River. Other portions of the correspondence between Pond and the Quartermaster General's Office show considerable interest in designs for specific buildings, standards for construction, and costs of buildings. After its reconstruction, the new buildings required for the Cavalry and Light Artillery school made Ft. Riley one of the larger posts within the Army.[21]

Standardization of Army Construction

During the 1890s, the Quartermaster Department re-instituted standardized building designs for all building types to control construction costs and standardize construction. In some cases, architect-designed buildings previously constructed at Army posts were incorporated as standardized plans; in other cases, talented Constructing Quartermasters contributed designs. Through the use of standardized plans, the Quartermaster Department in Washington, D.C., centralized building design. The Washington office sent building plans for new installations to the constructing quartermaster, who supervised site location and monitored material and labor contracts. The Quartermaster Department modified the standardized plans as needed. The standardized plans developed during the 1890s were used extensively during the Army's

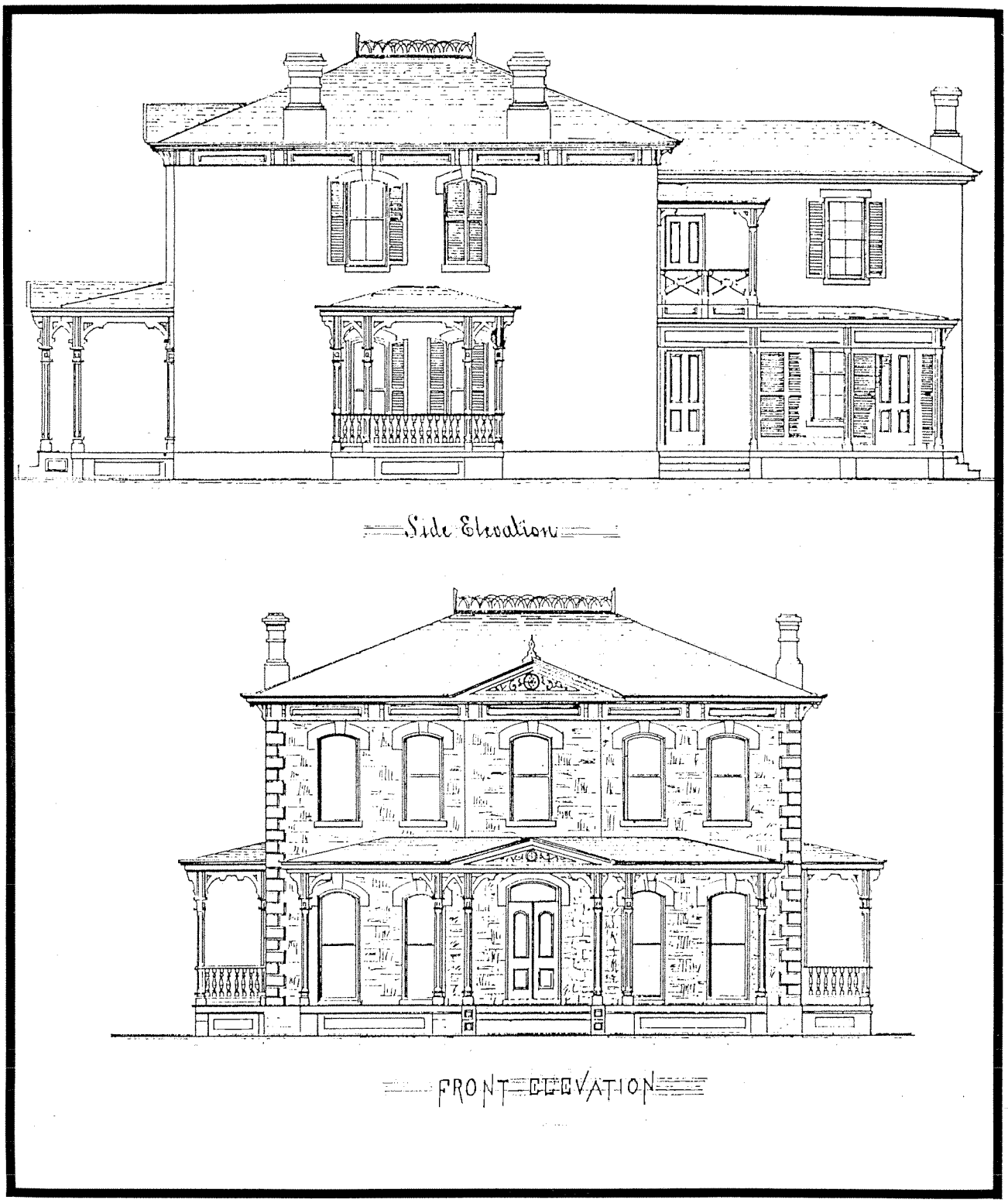


Figure II-12. Field officers' quarters designed by Alfred Giles for Ft. Sam Houston, constructed in 1881.

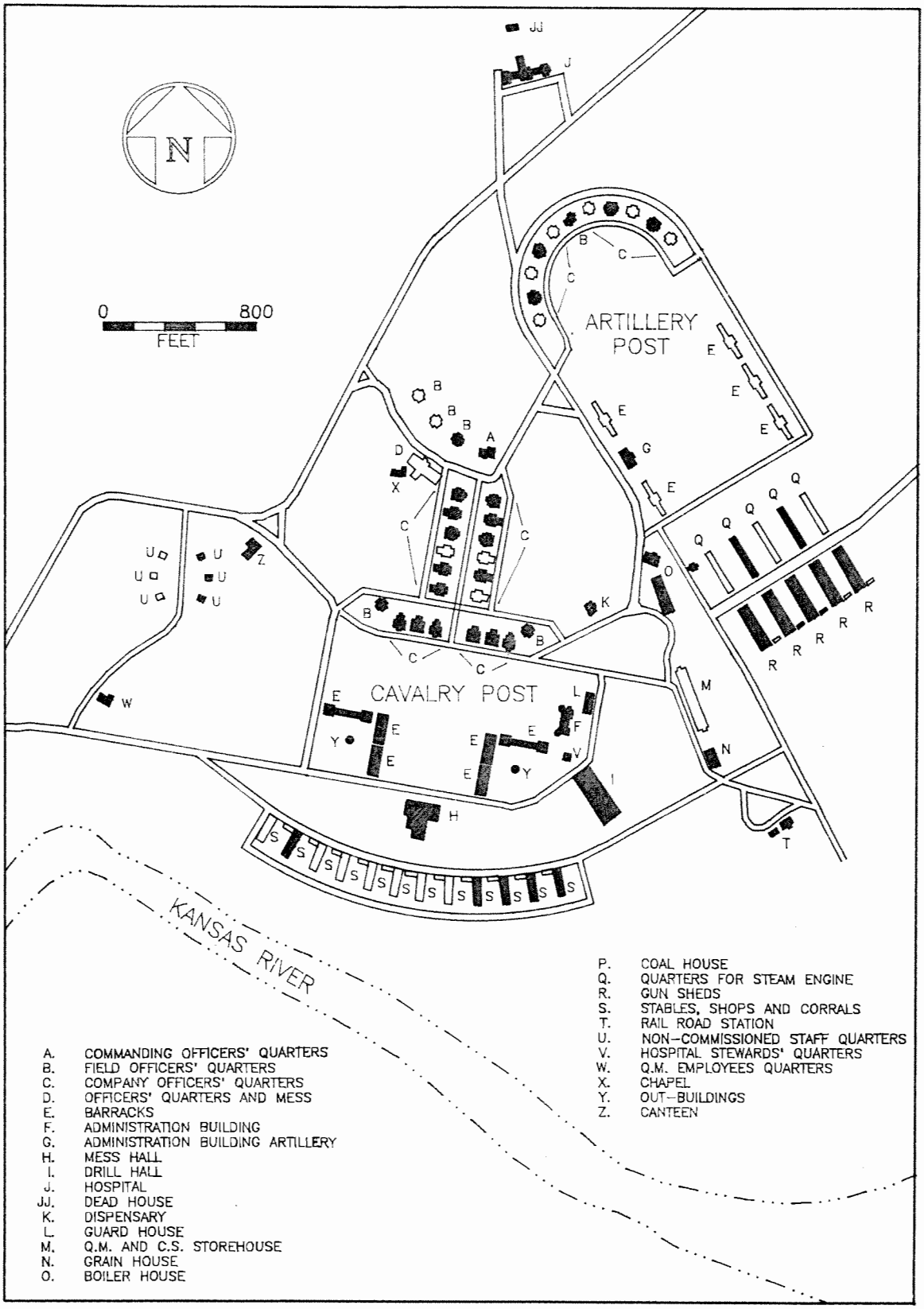


Figure II-13. Capt. George Pond's new plan for Ft. Riley, Kansas. Original plan indicates Capt. George Pond as quartermaster and W. H. Stair as civil engineer. Compare with Figure I-1. (Based on 1892 plan showing progress of construction, National Archives, Cartographic and Architectural Branch, RG 77, Fortification Files)

expansion of facilities that followed the reforms and reorganization under Secretary of War Elihu Root during the early twentieth century.[22]

At the end of the nineteenth century, the United States experienced a renewed interest in its colonial past. The Colonial Revival movement had a profound effect on architecture. Elements of early American architecture, primarily Georgian and Federal styles, were widely adopted for many building types, particularly domestic design. Colonial Revival architecture at the turn-of-the-century did not result in copies of colonial precedents, but in loose interpretations that freely mixed various elements.[23] The Quartermaster Department adapted Colonial Revival architecture for buildings constructed during the first decade of the twentieth century. The new construction often retained the building forms from the Victorian era, but displayed Georgian Colonial Revival motifs such as modillioned cornices and Tuscan-columned porches (Figure II-14). In the West and Southwest, the Quartermaster Department introduced designs using Spanish Colonial and Mission styles at the Presidio of San Francisco and Ft. Sill in 1911 (Figure II-15).

During the first decade of the twentieth century, the Quartermaster Department began to employ experienced civilian architects and draftsmen to augment the officers of the Division of Construction and Repair. One civilian architect who had a dramatic impact on Army planning and construction during the 1930s began his career in the Quartermaster Department in 1903. Francis B. Wheaton (1867-1931), formerly of McKim, Mead and White, transferred from the Architect of the Treasury to the Quartermaster Department and remained there until his death in 1931.[24] The inclusion of professional architects in the Quartermaster Department is indicative of the growing conviction that architecture constituted a distinct profession, different from engineering or construction. It is also illustrative of the Army's desire to control construction, by having architects within the Quartermaster Department, rather than contracting with civilian architects.

Ft. Benjamin Harrison, constructed between 1904 and 1909, is an example of Army construction at the beginning of the twentieth century. The Army began to acquire land near the city of Indianapolis, and, in 1904, assigned future Quartermaster General B. F. Cheatham as constructing quartermaster.

In September 1904, Cheatham sent a proposed sketch for the post to the Quartermaster General's Office. The plan involved the use of a relatively level piece of ground that sloped downward on three sides. He placed the officers' housing along a winding street at one end of the parade ground.[25] Apparently the Quartermaster General's Office changed the plan and placed the officers' housing along one side of the parade field, facing the barracks. The approved plan also specified curved, rather than straight, roads surrounding the parade field. Cheatham's instructions directed him to ensure that "the front of each building shall be in a direction parallel to the tangent at the center line of the building - that is, the building will face in a direction normal to the curve at its center."[26]

The remainder of the correspondence between the Quartermaster General's Office indicates that by this time the use of standardized building plans had become common practice. Cheatham was directed to follow all plans scrupulously and to request permission for the slightest departures from the plans. Correspondence concerning water, sewerage, and other utilities suggests that these issues received more attention than the aesthetic aspects of the site layout.[27]

The lack of a clearly articulated policy regarding installation planning accentuates the difficulties in assessing the reasons behind decisions. The evident attention to landscaping principles in the layout of these facilities indicates a concern for the design of the installations. Yet, the War Department had no established, clearly articulated policy regarding how an installation should be designed. The Army Regulations of 1904 specified that posts should be made attractive, but did not provide further guidance as to what constituted an attractive post.[28]

The practice of organizing buildings around a parade ground continued into the early twentieth century.

Beaux Arts Architecture and Planning

One of the most important planning philosophies to emerge from the latter decades of the nineteenth century originated from l'Ecole des Beaux-Arts in Paris. Important design precepts included symmetry of plan, strong visual axes, and classically-inspired monumental architecture. The work of many prominent Beaux-Arts trained or influenced architects was featured at the Columbian Exposition of 1893.

While most new Army construction utilized Quartermaster standardized plans during the first decade of the twentieth century, two prominent installations received particular attention in design: the War College at Washington Barracks (now Ft. McNair in Washington, D.C.) and the U.S. Military Academy at West Point, New York. The War College was established as part of the Army reorganization of 1901. The site utilized the old Washington Arsenal at Greenleaf Point. When the site was chosen for the new college, the Army made efforts to integrate the plan of the new installation with the McMillan plan proposed for the city of Washington, D.C. Charles McKim, principal of the noted architectural firm of McKim, Mead and White and active member of the Mcmillan Commission, suggested the general plan for the new installation. The installation plan exemplified the Beaux-Arts planning ideals. The plan was symmetrical, with the War College building serving as the major focus of the installation both from the land and water approaches (Figure II-16). The choice of architectural style for the War College building was Roman Classicism, reflecting the military grandeur that once was imperial Rome. The complementing officer housing, non-commissioned officer housing, barracks, and supporting buildings were designed using Georgian Colonial Revival motifs. The architectural firm of McKim, Mead and White prepared the installation plan, architectural drawings, and specifications; Captain John Sewell of the Corps of Engineers supervised on-site construction. The installation was completed in 1908, although not to the full extent of the McKim, Meade and White plan.[29]

In 1902, Congress authorized a major architectural competition to add eleven new buildings and to create a cohesive plan for the U.S. Military Academy at West Point, New York. Ten nationally-prominent architectural firms entered the competition, which was won by the architectural firm of Cram, Goodhue, and Ferguson. Their Gothic Revival buildings, which complemented the architectural tradition established during the nineteenth century at West Point, represented the single greatest expansion of the installation, and the one that had the greatest impact on its overall present appearance. While the architectural "style" of the campus was Gothic Revival, the selection of a master plan through a design competition and the winning plan's formal, symmetrical arrangement of large ensembles of buildings around axes are firmly within the Beaux Arts planning tradition.[30]

Ralph Cram, one of the West Point architects, recounted the sometimes difficult relations between civilian architects and cost-conscious Army planners in his memoirs, *My Life in Architecture* (1936):

> We were warned that, intentionally or not, the relations of the Government with architects had usually resulted either in breaking their hearts or their bank accounts. We discounted this ... Besides, we were young and this was our first Government job. We became more wise in later years.[31]

Beaux Arts planning and architecture is particularly evident at naval installations. Between 1890 and 1918, the Navy and Marine Corps experienced dramatic changes: heavily armored steel

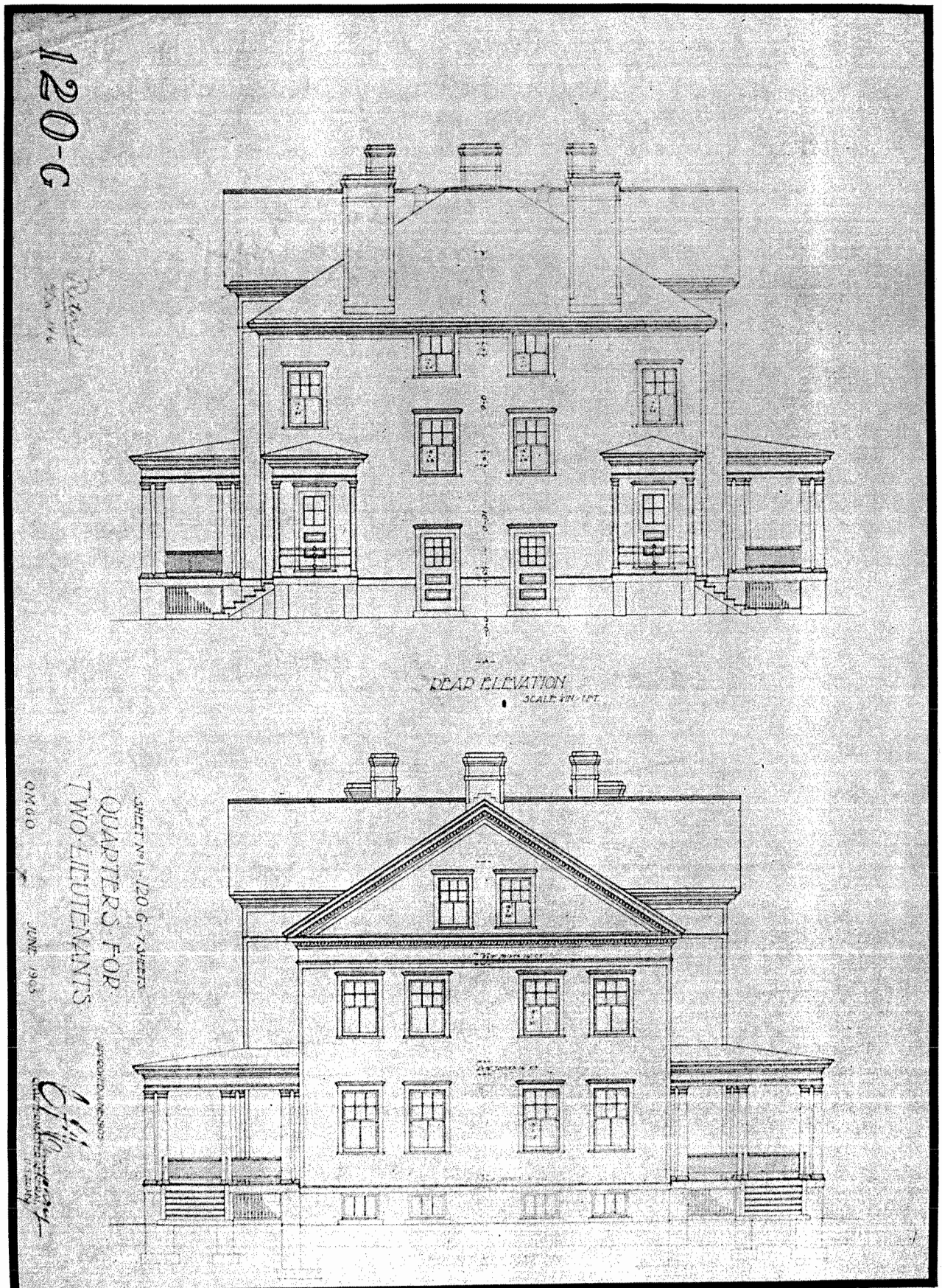


Figure II-14. Quartermaster 1905 standardized plan for quarters for two lieutenants. (From Grashof, *Standardized Plans 1866 - 1940*, Vol. 3, 1986; original drawing source: National Archives, Cartographic and Architectural Branch, RG 77, P.I. NM-19, E. 411-#120-G)

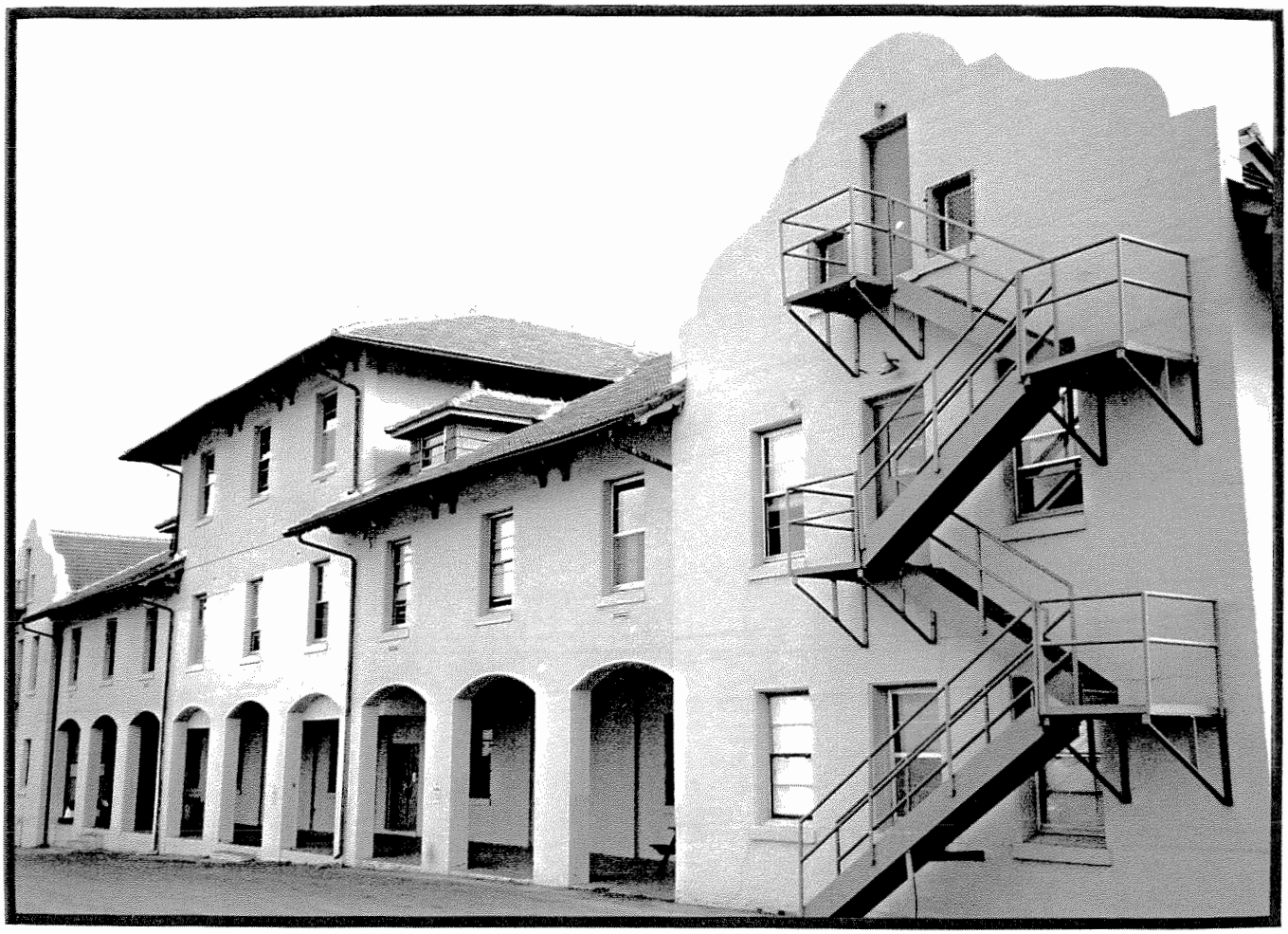
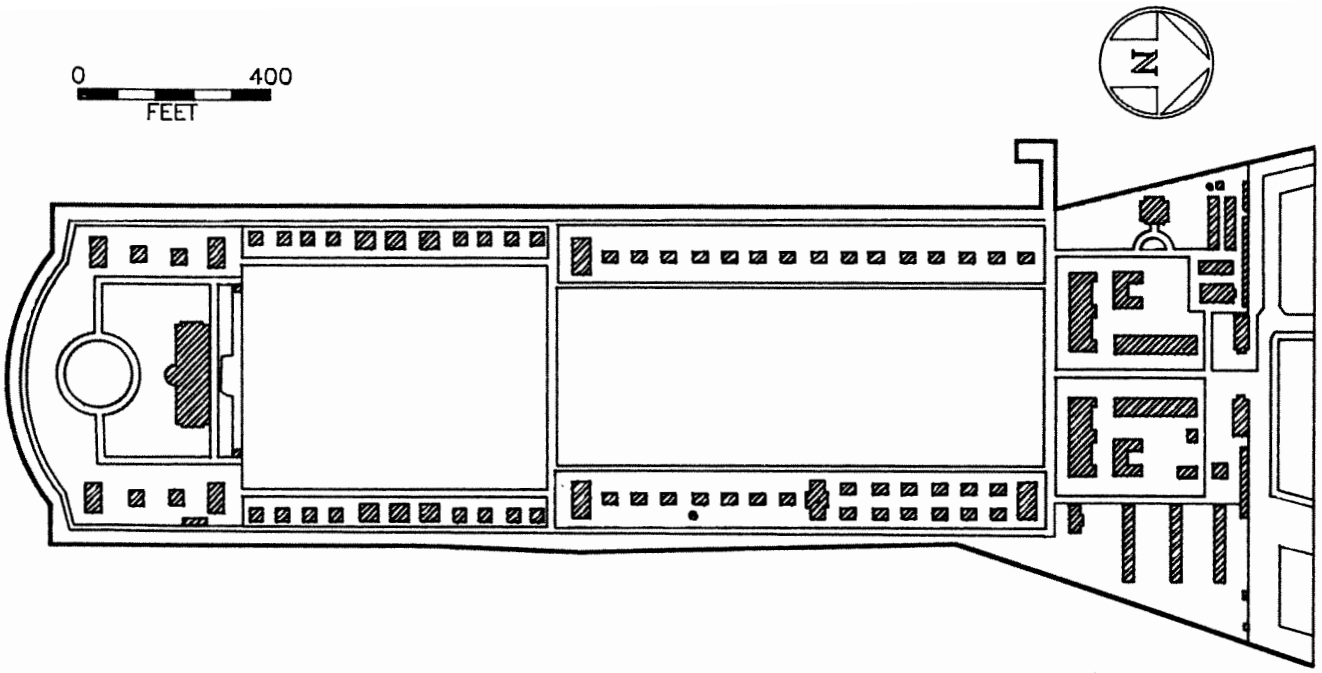


Figure II-15. Spanish Mission Revival-style barracks constructed in 1911 (Building 1607, Ft. Sill, Oklahoma).



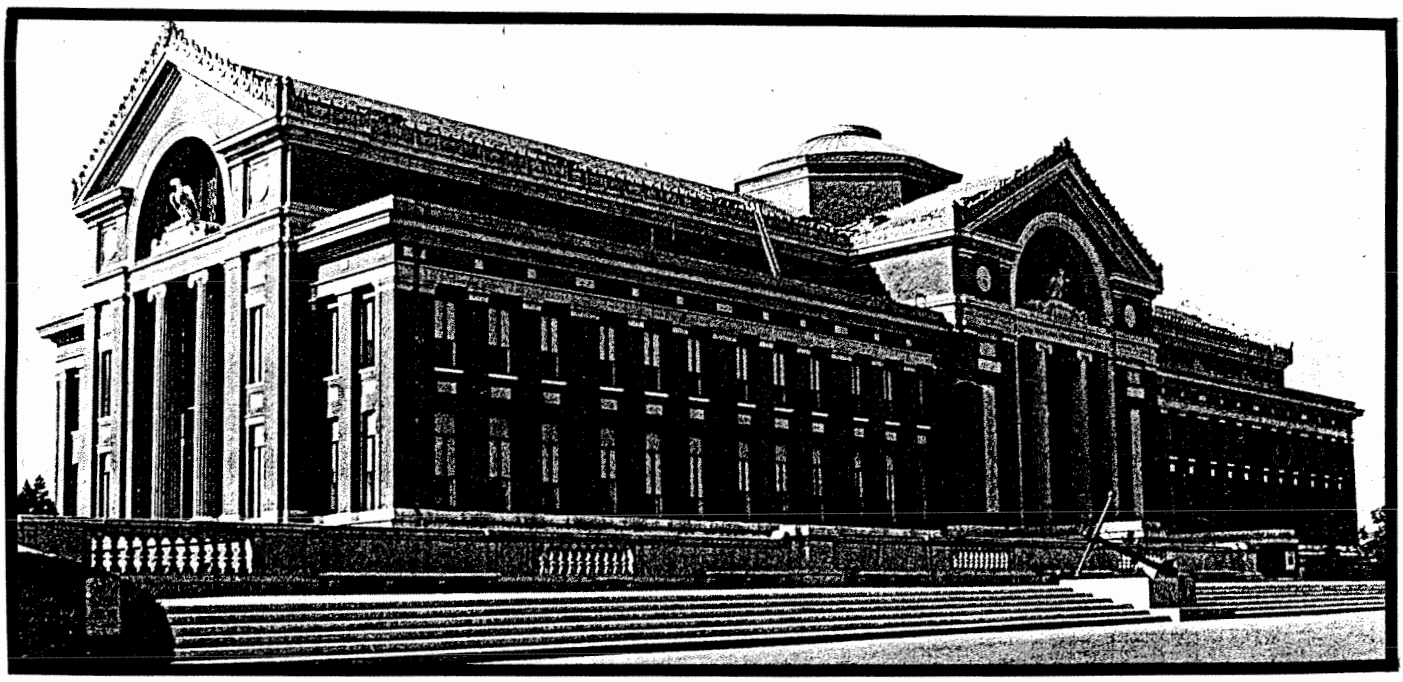


Figure II-16. Charles McKim, of McKim, Mead and White, designed the Army War College and Engineers Post, *above*, and its centerpiece, the War College building, *below*.

warships replaced wooden sailing ships; wireless telegraph and radio revolutionized communications; technological advances included new weapons, submarines, and aircraft. On-shore facilities reflected the national effort to modernize the Navy into a world power. During this period, the Navy expanded industrial facilities at its shipyards, and established new research and development and training facilities. The design of new installations often incorporated Beaux Arts planning concepts. At shipyards, where new construction expanded an existing plan, the architectural design of the individual facilities often utilized structural innovations within an exterior marked by heavily ornamented and monumental classical facades.

Though the Bureau of Yards and Docks, in theory, controlled construction at shore installations, other bureaus controlled the construction of special-function installations until 1911, when all naval public works were placed under the jurisdiction of the Bureau of Yards and Docks. The Bureau of Navigation, for example, maintained responsibility for the Naval Academy, the War College, and the Naval Observatory. When its facilities required expansion, the Bureau of Navigation procured plans, provided estimates, procured appropriations from Congress, and supervised construction.[32] To construct its new installations, the Bureau of Navigation contracted with noted civilian architects who designed new installations that embodied Beaux-Arts ideals.

The Naval Observatory in Washington, D.C. was the first installation completed for the Bureau of Navigation. Noted New York architect Richard Morris Hunt, trained at l'Ecole des Beaux Arts in Paris, won the design competition. Completed in 1893, Hunt's observatory is classically inspired (Figure II-17). The buildings were sited to take advantage of the sloping hill. Curving streets and walkways link the buildings.[33]

In 1895, the Board of Visitors of the Naval Academy issued a report condemning the extant facilities and recommending a complete reconstruction of the academy. Noted architect Ernest Flagg was commissioned to develop a master plan for a new academy, and in 1899, the Navy commissioned Flagg to rebuild the Academy. New construction commenced and continued during the first decade of the twentieth century. Flagg's design for the new Academy was a prominent example of Beaux-Arts classicism. Major elements of his plan included rigid axial symmetry, classically-inspired buildings, and impressive siting (Figure II-18). The main academic buildings were constructed of stone in the French Renaissance style. The Chapel, the Superintendent's Residence, and additional officers' housing, also designed by Flagg, were constructed of white brick. In choosing Flagg as architect for this project, the Navy espoused the City Beautiful and "White City" ideals exemplified in the Columbian Exhibition of 1893.[34]

A third installation that reflected Beaux-Arts planning ideals was the Great Lakes Naval Training Station, Illinois, constructed between 1906 and 1911. This installation represented a major departure for the Navy; it was a complete, permanent, on-shore recruit training facility that included barracks, drill hall, instruction buildings, officer housing, infirmary, utilities, and support buildings. Jarvis Hunt, a nephew of Richard Morris Hunt, was selected to design the installation. Jarvis Hunt had moved to Chicago in 1893 to supervise construction of the Vermont State Building at the Columbian Exposition, and subsequently established an architectural practice in Chicago. For the training station, Hunt developed a formal, axial plan with monumental buildings located at the terminal points of the axes. The plan organized the installation into areas defined by their function. The buildings exhibit symmetrical facades and monumental ornamentation based on Roman and Italian Renaissance classical precedents.[35]

The Marine Corps also was expanded during this time period. During the late 1890s and early twentieth century, Congress authorized appropriations for construction and improvement of many Marine Corps barracks at naval shipyards. The expansion recognized Marine Corps successes in the Spanish-American War. The new reservations at shipyards generally were small, comprising one or two barracks, a complement of officer housing, and support buildings. The

reservations were arranged with the barracks facing a parade ground and officer housing located nearby. In many cases, the Marine Corps contracted with civilian architects. For example, the Marine Corps barracks at Philadelphia Navy Yard and the U.S. Naval Academy, were designed by Henry Ives Cobb, a noted Chicago architect (Figure II-19). Cobb's barracks combined elements of the Romanesque Revival architectural style. The Marine Corps barracks built at Norfolk Navy Yard, Virginia, were designed by Bruce, Price and De Sibour, architects from New York City. De Sibour also designed housing for Marine Corps officers at Pearl Harbor and at Puget Sound Navy Yard.

The oldest Marine Corps installation, the Barracks in Washington, D.C., was rebuilt during the first decade of the twentieth century. The main and band barracks, constructed between 1903 and 1907, were designed by Hornblower and Marshall, a Washington, D.C., architectural firm. The main barracks, a long, two-story building, featured three-story pavilions. The central pavilion was ornamented with a machicolated brick cornice and crenelated limestone parapet (Figure II-19). Both the main barracks and the smaller band barracks included a ground floor arcade along the length of the building. Single and duplex officers' quarters were added at the same time. These square brick buildings with simple detailing reflected the influence of the Colonial Revival style.

Navy Yards

At their industrial facilities, both the Navy and the Army struggled to keep pace with changes in technological production processes. Industrial processes involved new raw materials and generally produced larger final products. Production facilities generally became more specialized. In some cases, large buildings housed complicated production processes. Contemporary construction technology was utilized to span larger interior spaces and to ensure proper fireproofing.

The most spectacular industrial facilities were located at naval shipyards. Naval civil engineers kept pace with contemporary industrial architecture. In the 1900 annual report, the Chief of the Bureau of Yards and Docks wrote of a building under construction at the Norfolk Navy Yard, "like most of the buildings now being erected in the Navy yards, it is of steel-frame construction with brick wall filling, and with fireproof floors and doors."[36]

As the technology of ship building changed, so did on-shore support facilities. Utilities, hoisting machinery, cranes, and heating plants were introduced at Navy yards during the late 1890s. The use of steel in ship building required larger smithies, plate-working shops, and foundries. Industrial facilities constructed during the first decade of the twentieth century followed popular high-style architectural models, including Beaux-Arts, Neo-Classical, Italian Renaissance Revival, and Colonial Revival (Figure II-20).

As the Navy modernized shore facilities, it integrated the utilities required to operate the machinery into the infrastructure of the shipyard. In 1904, Congress gave the Bureau of Yards and Docks the responsibility to construct central power plants at each yard to provide electricity, steam power, heat, and compressed air. The Bureau contracted with the industrial architecture firm of Stone and Webster to study centralized power at six installations located along the Atlantic Coast.[37] Over the next ten years, massive central power plants were constructed at each yard. At Charleston Navy Yard, South Carolina, the central power plant is classically inspired; at Pensacola and Philadelphia, the plants reflect the Italian Renaissance architectural style (Figure II-20).

Before World War I, local variations, due to the limited autonomy of the civil engineer on site, characterized the industrial buildings at naval facilities. However, centralized oversight by the

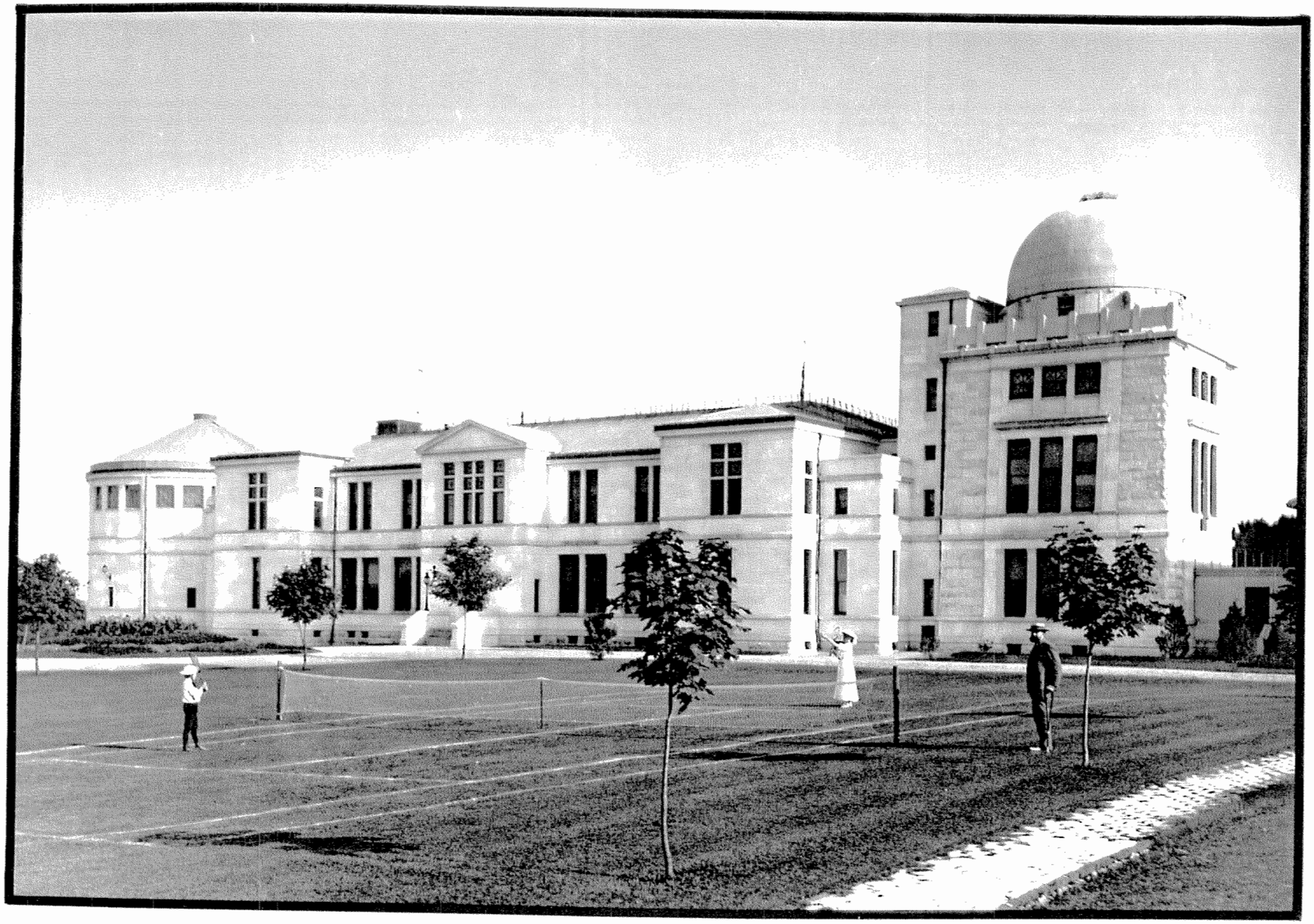


Figure II-17. Naval Observatory Building designed by Richard Morris Hunt completed in 1893 at the U.S. Naval Observatory, Washington, D.C. (Courtesy of U.S. Navy)

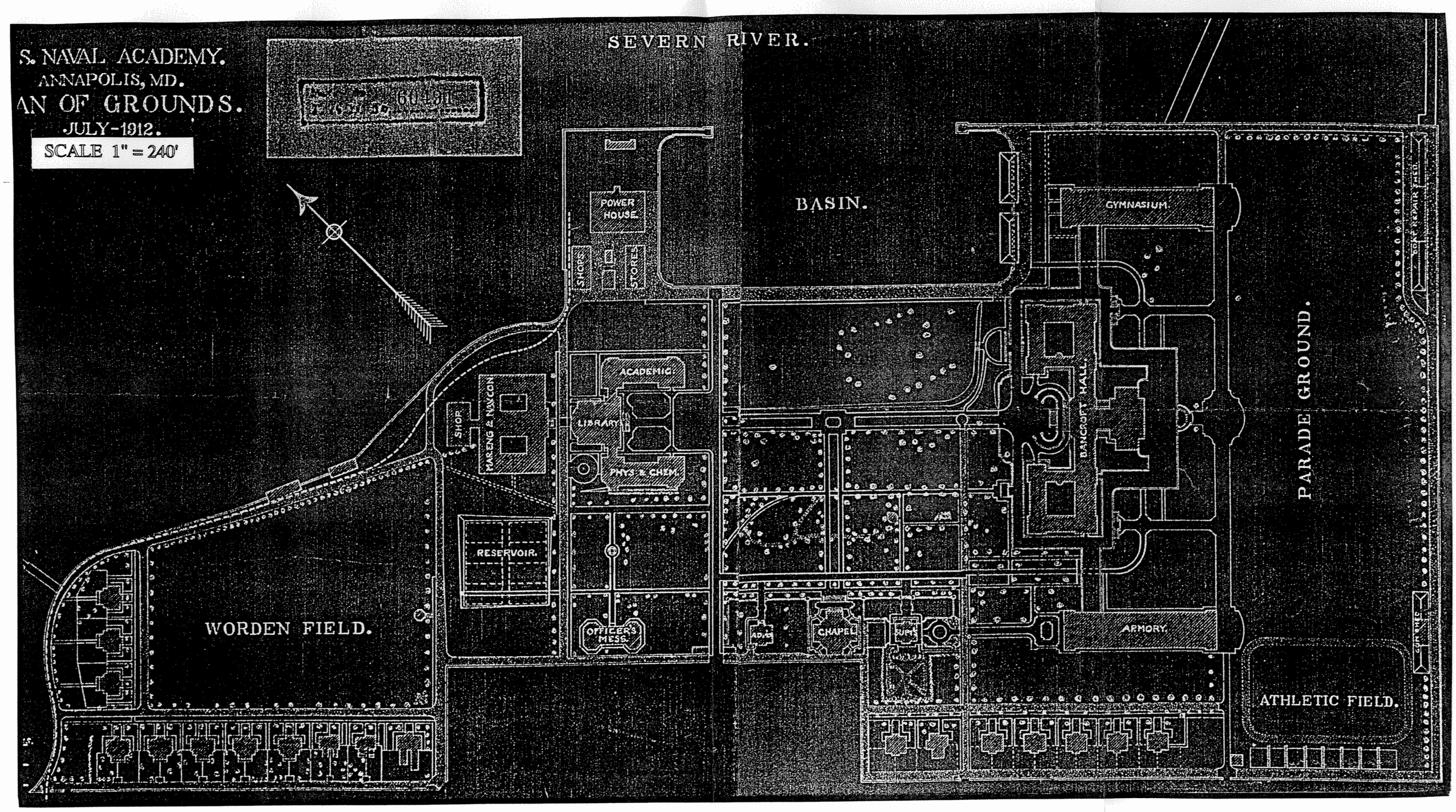


Figure II-18. 1912 plan of U.S. Naval Academy, Annapolis, Maryland, designed by Ernest Flagg. (From National Archives, Cartographic and Architectural Branch, RG 71, Bureau of Yards and Docks, 507-3-6)

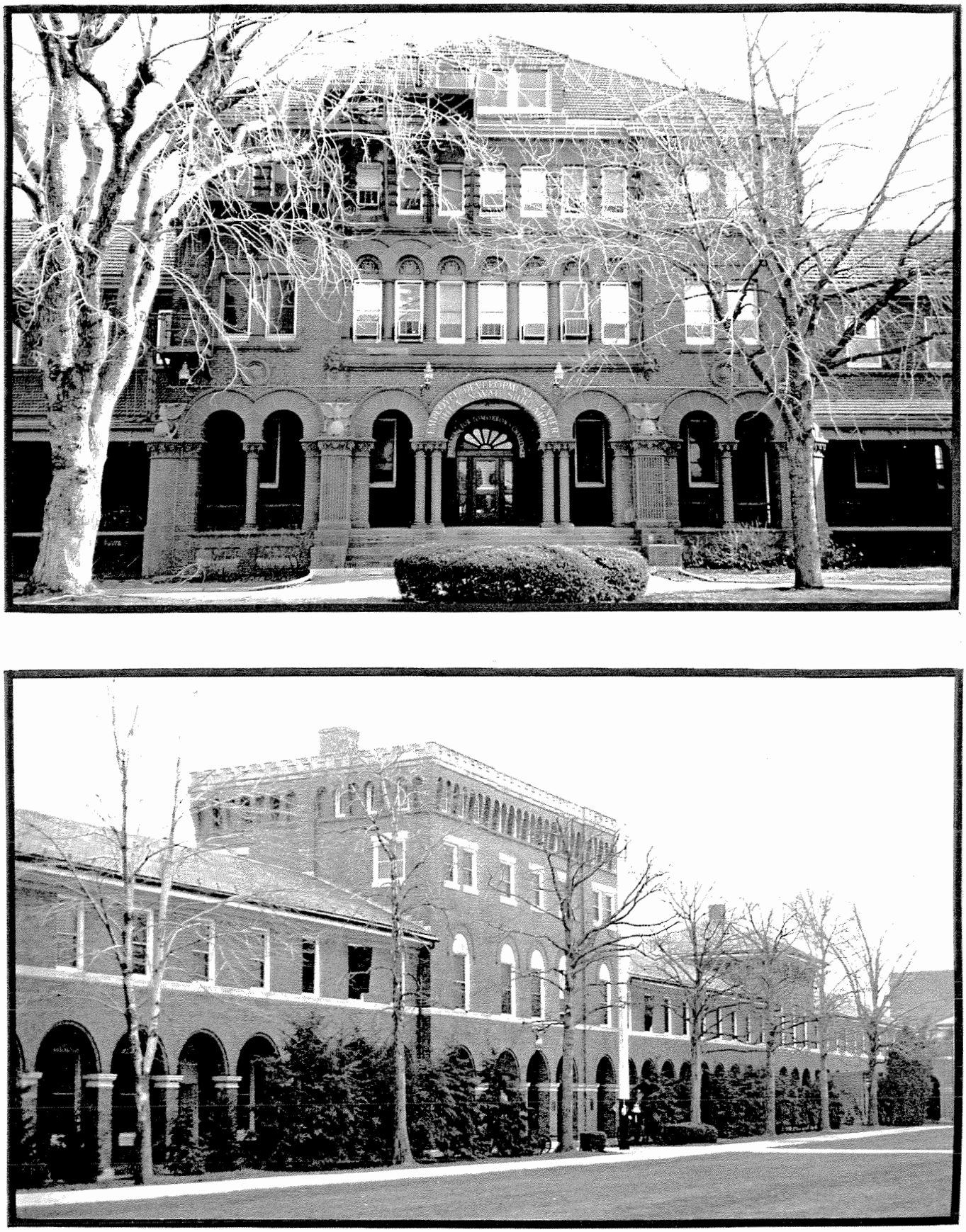


Figure II-19. Central block of Marine Corps Barracks, Philadelphia Navy Yard, *above*. Main barracks building at Marine Corps Barracks, Washington, D.C., *below*.

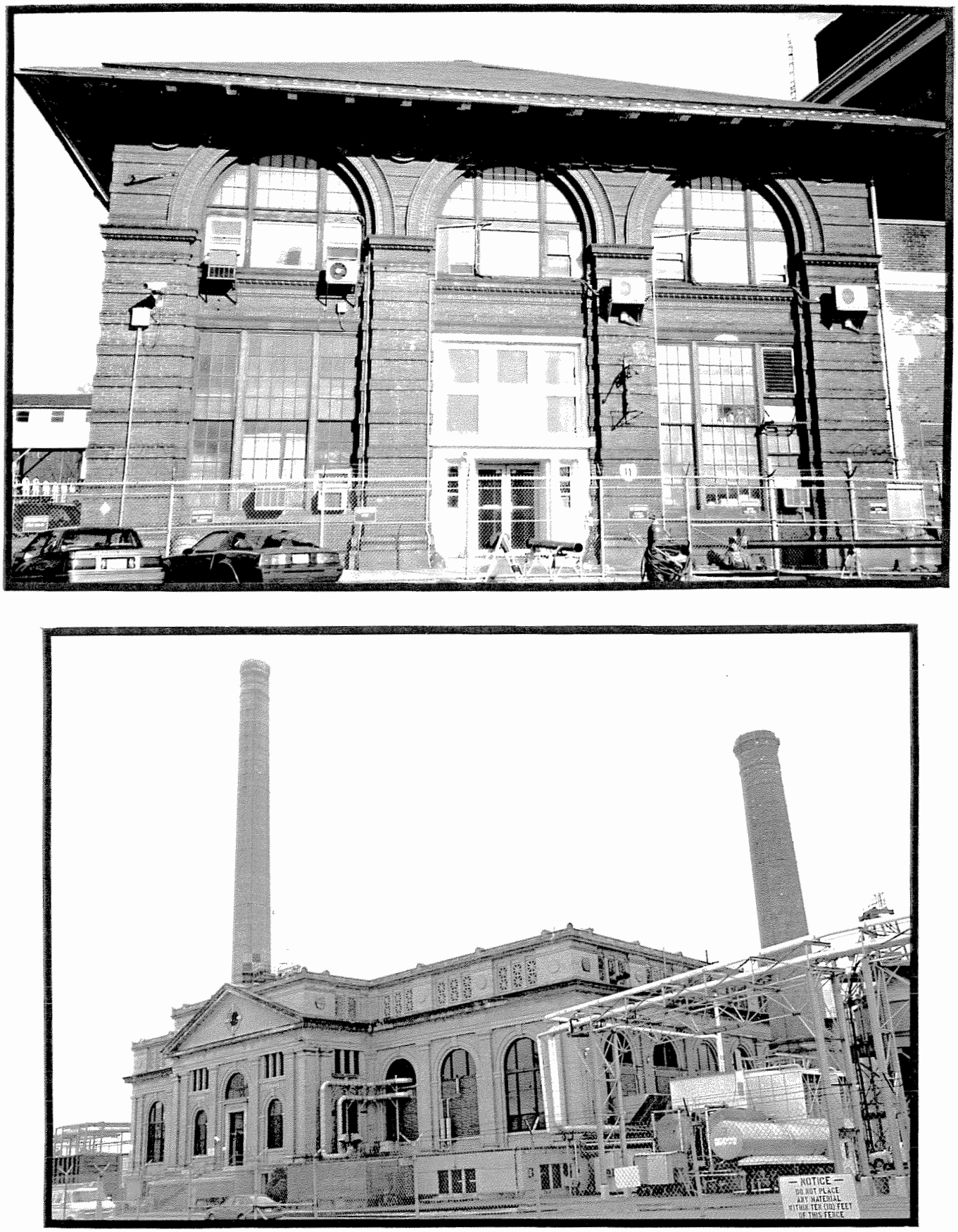


Figure II-20. 1903 shop building (Bldg. 11), Philadelphia Navy Yard, Pennsylvania, *above*. Central power plant (Bldg. 32) constructed in 1909, Charleston Navy Yard, South Carolina, *below*.

Bureau of Yards and Docks, the rotation of civil engineers among installations, and the general trends in industrial architecture tended to encourage similarities between buildings at various installations.

World War I: Temporary and Permanent Construction, 1917 - 1918

When the United States entered World War I in April 1917, military construction needs rose sharply. The military required new training cantonments and stations; new industrial buildings to support expanded industrial production; and, new types of facilities to support technological advances such as the airplane and submarine. Both the Army and the Navy struggled to meet production and training demands by allocating limited resources efficiently among competing demands. To save time and resources, the military used temporary construction widely.

In the spring of 1917, the Army's Construction and Repair Division in Washington, D.C., had three officers and 53 civilians. The Construction and Repair Division had few plans for temporary construction and no plans for the organization and direction of a high-speed construction effort. On May 7, 1917, the Quartermaster Department received orders to construct thirty-two divisional cantonments by September 1. The Quartermaster Department formed a Committee on Emergency Construction comprised of men with architectural and construction expertise to oversee the massive effort. Committee members included: William A. Starrett, president of the architectural firm of Starrett & Van Vleck, of New York City; Morton C. Tuttle, of Aberthaw Construction Company of Boston; and, Clemens W. Lundoff, vice president of Crowell, Lundoff and Little of Cleveland; Frederick Law Olmsted, landscape architect; Leonard Metcalf, noted designer of water and sewerage systems; and, George W. Fuller and Asa E. Phillips, consulting engineers. The committee was able to mobilize many talented civilian architects, engineers, construction experts, and contracting officers to complete construction of the thirty-two cantonments.[38]

By 1914, the Advisory Architect of the Constructing Division of the Quartermaster Corps had developed plans for temporary mobilization camps. The plans, designated the 600 series, depicted modular buildings of wooden-plank construction sheathed in board-and-batten siding. A 1917 revised plan for barracks depicted stud construction sheathed in horizontal siding.[39] The typical World War I recruit training cantonment comprised barracks, laundries, bakeries, mess halls, hospitals, infirmaries, storehouses, stables, latrines, and administrative buildings, constructed as temporary one-story, wooden-frame buildings. Cantonment buildings were arranged linearly, to house troops in organized military units. Buildings related to infrastructure, including heating plants and electric substations, generally were constructed of more permanent materials such as brick. Recruit training cantonments established during World War I included Ft. Devens, Massachusetts; Ft. Dix, New Jersey; Ft. Gordon, Georgia; Ft. Jackson, South Carolina; Ft. Lee, Virginia; Ft. Lewis, Washington; and, Ft. Meade, Maryland. World War I temporary construction is an early example of large-scale modular construction and formed the basis for the standardized 700 and 800 series construction plans developed for World War II mobilization.

In addition to training cantonments, the Army expanded industrial production. The Ordnance Department contracted with civilian engineering firms to design and construct industrial complexes. The work of the firm of Stone and Webster is found at Rock Island Arsenal, Illinois, and Watertown Arsenal, Massachusetts. The new buildings were constructed with reinforced concrete frames and large expanses of industrial sash windows. These production facilities reflected modern industrial design and marked a distinct departure from the revivalist aesthetic that had characterized previous military industrial construction.[40]

The Navy also expanded its industrial facilities and established new installations to meet wartime needs. The Navy rapidly expanded industrial facilities to support its fleet. In general, construction during World War I was utilitarian and functional to meet the demands of wartime. New buildings incorporated contemporary building methods and appearances: steel frame with corrugated metal walls or reinforced concrete frames, with concrete slab walls or infilled with brick (Figure II-21). Large banks of steel-frame, industrial sash windows lighted the interior. These buildings marked a major change in the Navy's industrial architecture, which less than ten years before the start of World War I had been dominated by Beaux Arts classicism. By the end of World War I, the Navy's shipyards had become modern ship construction and repair yards. New facilities included new power plants, shops, shipways, dry docks, cranes, and foundries (Figure II-22). The Navy also constructed wooden-frame, temporary buildings at its training stations to house and supply recruits, and at yards to supplement existing buildings.

The third major type of World War I facilities were airfields. In January 1917, the Army Signal Corps contracted with noted industrial architect Albert Kahn (1869-1942) to provide plans and specifications for Army airfields. Kahn submitted a set of plans for temporary airfields that the Army utilized to build temporary airfields nationwide during World War I. The typical World War I airfield plan consisted of twelve wooden-frame hangars, with accompanying barracks, administration, and support buildings. In general, the hangars were aligned on the flightline; however, the hangars at Brooks AFB, Texas, originally were arranged in a shallow arc. Some of the early airfields included Bolling AFB, Washington, D.C.; Chanute AFB, Illinois; Kelly AFB, Texas; March AFB, California; Maxwell AFB, Alabama; and Selfridge ANG, Michigan.

Three permanent airfields were begun either immediately before or during World War I. Albert Kahn designed two permanent airfields for the Army; Langley Field, Virginia, and Rockwell Field, San Diego, California. At Langley, the housing was designed as Tudor Revival, like other examples of Kahn's domestic work, while the brick hangars, laboratories, and support buildings displayed massing and detailed tile patterns similar to Kahn's commercial and academic architecture (Figure II-23).[41] At Rockwell Field, the local architectural firm of Mead and Requa, whose design signature combined elements of Mission Style with the Arts and Crafts, assisted Kahn.

In 1918, the Navy contracted with architect Bertram Grosvenor Goodhue to design its permanent air station located at North Island, San Diego, California, adjacent to the Army's Rockwell Field. Goodhue, a noted architect of public and commercial buildings, designed a bi-axial plan for the station with Spanish Colonial revival architecture. The buildings have exterior decorative ceramic tiles, clay tile roofs, and ornamental iron work. The work of Kahn at Langley and Rockwell Fields and of Goodhue at North Island prefigured the military's later adoption of the principles of community planning and regional revival architectural styles for the expansion of installations during the 1930s.

Inter-war years: Regional Architecture and Community Planning, 1919 - 1940

Immediately after World War I, the federal government drastically cut military funding appropriations. Necessary construction projects started during the war were completed, but few new ones were started. Installations established or expanded during World War I faced a tenuous future as the military re-evaluated its peace-time role following the Armistice in November 1918.

Beginning in 1926, the Army began construction programs to replace World War I temporary wooden buildings and to construct permanent airfields. The Navy and Marine Corps began to develop new aviation and training installations. Public works construction projects to alleviate the effects of the Great Depression provided funds for military construction. Efforts to

Figure II-21. Concrete frame, 1918 general storehouse (Bldg. 4) at Naval Base Charleston, South Carolina.

Figure II-22. 1918 Foundry (Bldg. 172) at Norfolk Naval Shipyard, Virginia. (Courtesy of U.S. Navy)

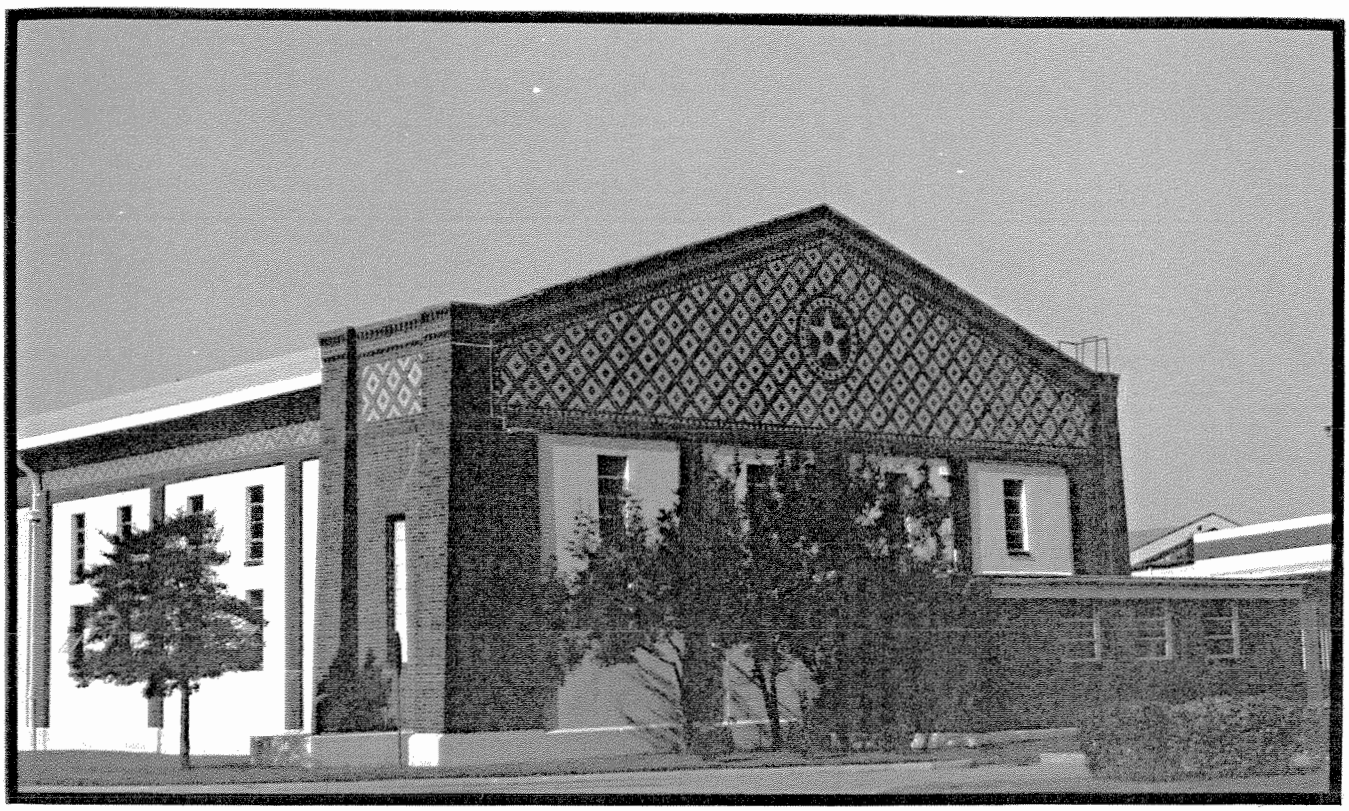


Figure II-23. Hangar (Bldg. 781) designed by industrial architect Albert Kahn in 1918 at Langley AFB, Virginia.

improve the quality of life and the aesthetic beauty of military installations mark this period. Principles of city planning were used to organize the complex spatial requirements of modern military activities and to provide a "healthful" suburban environment for residents. The use of regional and colonial period motifs added to the suburban feel of the new construction, which provided housing to non-commissioned officers and to Navy enlisted men in larger numbers than ever before.

Army Construction

After World War I, the Army struggled with a nationwide military housing shortage. Secretary of War Weeks reported in 1924 that 40,000 troops lived in "unsuitable" conditions; these troops constituted approximately one-third of the Army's enlisted men.[42] Housing was especially critical at installations located in cold climates. The Army undertook limited construction at permanent installations, but had no overall building program. For example, around 1924 at Ft. Benning, Georgia, and Edgewood Arsenal, Maryland, officers' housing was constructed using the Dutch Colonial Revival architectural style; however, the housing at Ft. Benning was criticized as unsuitable for the hot Georgia summers.[43]

In 1926, the U.S. Congress enacted Public Law No. 45 authorizing the Secretary of War to dispose of 43 military installations, or portions thereof, and to deposit the money received from sales into a special fund designated the "Military Post Construction Fund" to construct barracks, housing for non-commissioned officers, and hospitals. The first monies, totalling over 7 million, were expended in 1927. Construction was targeted at those installations that the Army desired to retain but that had severe deficiencies. In addition, the Air Corps Act of 1926 authorized a five-year aviation expansion program to recruit additional men and purchase new aircraft. New facilities designed specifically as aviation installations were planned as part of this expansion. Many currently active Army and Air Force installations are products of these inter-war construction programs.[44] The Quartermaster Corps administered the construction of Army Air Corps installations, which were included among the specific appropriations made for new construction at Army posts.

The Construction Division of the Quartermaster Corps organized all aspects of the nationwide construction program. Led by Major General B.F. Cheatham, Quartermaster General, the Construction Division assembled an impressive group of military and civilian architects, engineers, planners, designers, and landscape architects to oversee the program during the late 1920s and 1930s. The first Chief of the Engineering Division of the Construction Service was Lt. Col. Francis B. Wheaton. Luther M. Leisenring, formerly with architect Cass Gilbert, became Supervising Architect in the Office of the Quartermaster General in 1937. George B. Ford, a noted urban planner, retained as a consultant to the Quartermaster Corps, reviewed installation plans. Ford combined efficient, workable plans with planning concepts used in the City Beautiful and Garden City movements. The goal of the professional team was to develop efficient, cohesive, and pleasant environments within reasonable expenditures.[45]

Ford enunciated his philosophy in a 1929 issue of *The Quartermaster Review*. Although he praised the efficiency of design of traditional military posts, he criticized the use of straight lines in a post design. "However, it has been a well-known tradition of the Army in the past that whereas Army buildings and layouts must be practical, nevertheless they should look military. There seemed to be a feeling that any building or layout that was not foursquare and austere was effeminate and unworthy of the Army." He advocated creating useful and aesthetically pleasing environments, using vistas and irregular lines.[46]

A Quartermaster Corps officer, First Lieutenant Howard B. Nurse, provided further Insights into the process of installation planning. He compared the planning of Army posts to the new field of city planning. "The planning and developing must take such form as will secure the healthful conditions, promote the scientific training of troops, and also furnish the means of social intercourse." To achieve these ends, Nurse recommended a comprehensive plan for Installation growth. He further suggested planners should consider five principles: (1) unity, or the coordination of the various parts; (2) consonance in design of recurring patterns; (3) natural beauty, even while accepting natural differences in designs; (4) balance, usually along an axis; and (5) radiation, whereby parts of a community radiate from the center and return. He found parallels for these principles in examples of natural design, and even compared the military community to a living organism. Like Ford, Nurse advocated using topography in the design and layout of streets, avoiding straight lines, especially in residential areas. Although he conceded that many older posts had a charming appearance that increased with time, he believed that the future of installation planning depended upon a systematic application of the principles derived from city planning.[47]

In 1931, the Office of the Quartermaster General created a Planning Branch within the Construction Division, to ensure the "scientific planning and landscaping in the development of Army Posts and Air Fields." The new branch contained two landscape architects and two architects. In discussing the role of the Planning Branch, one writer again noted the emergence of city planning and its effect upon Army installations. "In the days gone by systematic planning as practiced today was unknown, ... That was as true with our towns and cities as with Army Posts." He further suggested that installation design should be governed by a concern for unity among the features, practicality for the inhabitants of the post, and an "interesting simplicity" in creating a good design. Post planning, like city planning of the era, the writer continued, involved the consideration of distinct, hierarchical areas: industrial areas (shops, warehouses, railroad spurs, heating plants, etc.); housing areas for enlisted men ("the industrial living area"), NCOs ("office workers area"), and officers ("executive living area"), plus the administrative and community buildings.[48]

The Army's planners applied these master planning concepts at installations that contained more land and quartered more troops than ever before. Functional, hierarchical arrangements of buildings and open space allowed the ordered development of these expanded posts. Unlike earlier posts, the parade ground was no longer the central feature. The days of arranging the primary buildings around the parade ground perimeter and mustering the garrison in formation on the parade ground were over. Parade grounds now served as landscape elements within an overall master plan that often incorporated multiple parade grounds within different functional areas linked by boulevards and vistas.

As befitted the new Army post, the Quartermaster Corps issued new standardized building plans. The new designs were created to respond to local climate conditions and to reflect local architectural history. Georgian Colonial Revival was used for installations from New England to Virginia, in the Midwest, and in the Pacific Northwest. Spanish Colonial Revival styles were used in the South, Western Plains, Southwest, and California (Figure II-24). Other regional designs, constructed as appropriate, included French Provincial in the Gulf States and English Tudor Revival.[49]

Though the Quartermaster Corps now included professional architects and planners, the practice of hiring civilian architects for particular projects was not discontinued completely. The venerable firm of McKim, Mead and White designed the first regimental barracks completed at Governors Island, New York, and the Infantry School at Ft. Benning. The Ft. Benning post chapel was designed by regional architects Hentz, Adler, and Schutze. At Ft. Monmouth, Philadelphia

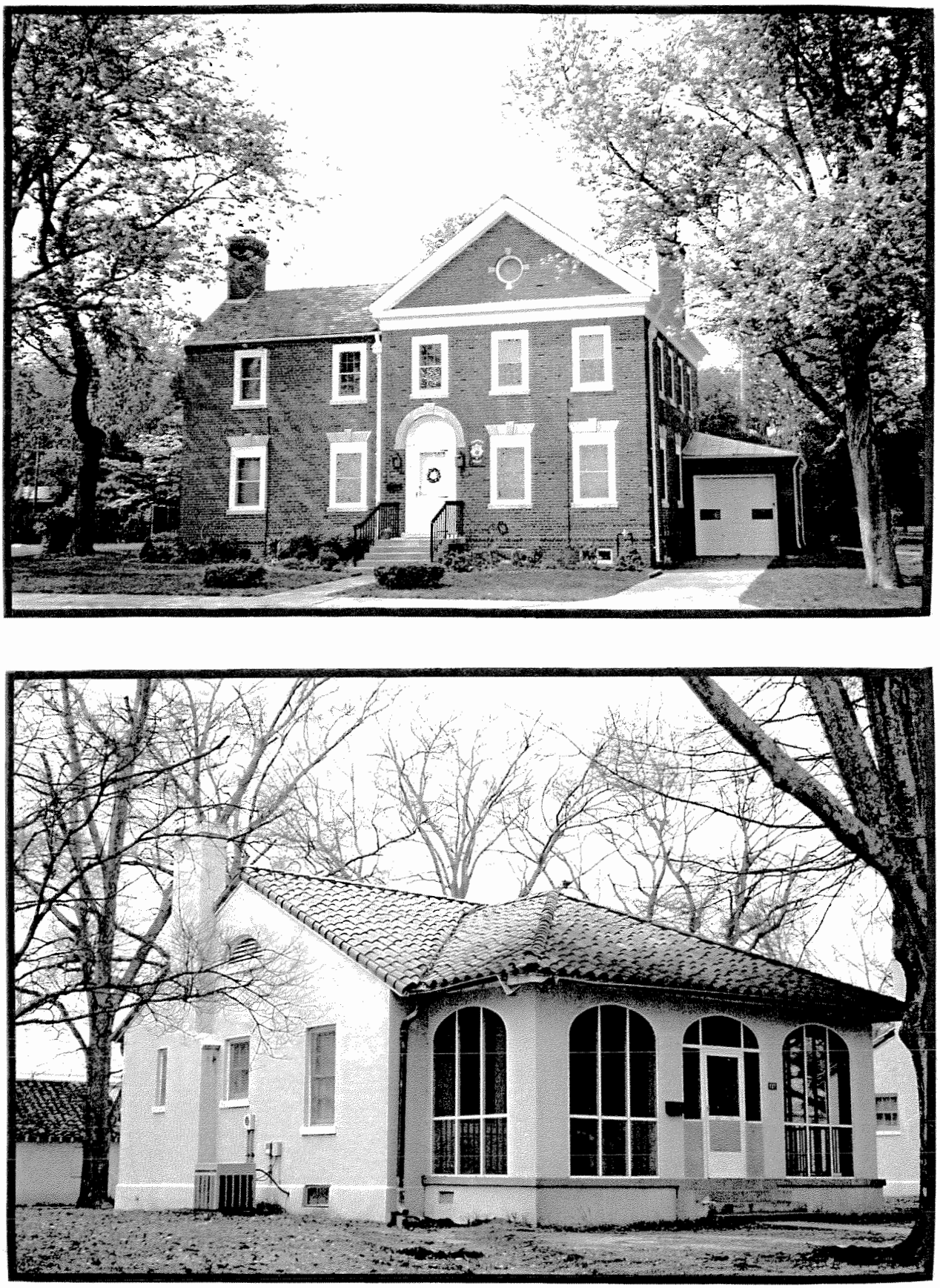


Figure II-24. 1930s Georgian Colonial Revival officers' housing at Ft. Knox, Kentucky, *above*. 1930s Spanish Colonial Revival non-commissioned officers' housing at Ft. Benning, Georgia, *below*.

architect Harry Sternfield designed the headquarters and New York architects Rodgers and Poor designed the Squier Laboratory.[50]

The new construction program and developments in installation planning were especially welcome to the Army Air Corps; by 1925, the Army had not yet constructed any new permanent Air Corps installations. Langley Field, Virginia, and the incomplete Rockwell Field, California, remained the Air Corps' only permanent facilities. A large portion of the Army's housing construction program during the inter-war years, as well as technical construction appropriations from Congress, went to the development of Air Corps installations.

Permanent airfields constructed during the early 1930s generally had symmetrical plans. For March Field, California, begun in 1926, the Office of the Quartermaster Corps developed a triangular plan based on a square mile. The flightline was located on the diagonal of the square, and buildings were arranged symmetrically in the resulting triangular area. The layout of Barksdale AFB, Louisiana, follows the same plan (Figure II-25). The hangars and support buildings defined the edge of the runway. A visually impressive boulevard ran from the main gate to the center of the base. Family housing lined the streets, which radiated from the central boulevard and emphasized the triangular plan of the installation.

The plan of Randolph AFB, Texas, is a unique design that illustrates the sophistication of post planning during this period and the greater degree of freedom that Air Corps planners enjoyed (Figure II-26). Unlike other installations where Quartermaster officers designed the post, a young Air Corps officer, Harold Clark, designed the plan and persuaded Brigadier General Frank Lahm to approve the design. The complex plan defines separate functional areas within a formal geometric pattern. The boundaries of Randolph AFB form a square, with flightlines defining two edges. A central axis contains the administration building, commander's quarters, officers' club, and cadet school. Officers' family housing is located within the interior of the square along streets formed in a pattern of concentric circles radiating from the officers' club at the center. The plan was intended to be practical for the base mission. Randolph was the Air Corps' primary flying school; the two runways on the edge of installation separated pilots of different levels of skill and avoided flights over the populated areas of the airfield. The square, with central and cross axes, provided four quadrants to separate different functions of the installation, while the inscribed circle emphasized the institutional hierarchy.[51]

During the late 1930s, airfield design changed. Airfields began to have longer, intersecting runways in an A-shaped pattern that accommodated a variety of planes with differing take-off requirements. Buildings were located to fit around the A-shaped runways. The barracks and administrative buildings were located as near to the flight line as possible. At Chanute AFB, remnants of this type of plan are apparent (Figure II-25).

By 1931, the construction program had provided permanent housing for 19,800 enlisted men, 304 non-commissioned officers, and 292 commissioned officers. Construction costs totaled over $30 million, with $16 million under contract, and advertisements out on about $3 million more. By 1933, appropriations reached nearly $80 million. Additional funding was made available under the National Industrial Recovery Act (NIRA) of 1933. The Work Relief and Public Works Appropriations of 1938 allocated over $13 million in WPA and $52 million in PWA funds for construction of Army housing. This money was spent at sixty-four installations for 1,091 sets of quarters, completed by January 1940. As early as 1938, the Quartermaster Corps was prepared to develop emergency plans in case of war. On June 15, 1940, the Adjutant General issued a directive halting all construction for family quarters and non-commissioned officers' quarters. On December 1, 1941, the Army consolidated all construction functions under the Corps of Engineers.[52]

Navy Construction

Naval disarmament treaties signed during the early 1920s and the national mood of isolationism prevented large appropriations for the maintenance and improvement of the nation's naval forces. Immediately following World War I, the Navy constructed new facilities at only a few installations with permanent specialized missions, such as weapons production and testing, aviation, and training. During the 1930s, growing threats to international security led to increased military funding. In 1931, two deficiency acts allocated a total of $7,800,000 to the Bureau of Yards and Docks to upgrade the Navy's shore establishments throughout the nation. The Relief Construction Act of July 1932 provided the Bureau of Yards and Docks with $10 million. In 1933, the National Industrial Recovery Act (NIRA) allocated $28 million for naval public works. From 1934 to 1937, naval public works appropriations totaled nearly $100 million.[53]

The new construction expenditures illustrated the Navy's growing diversity of installation types and increased emphasis on the Pacific theater. The Navy and Marine Corps constructed new training and aviation stations, which required permanent facilities for recruit training. These on-shore facilities also provided amenities to naval personnel that had not been typically included on naval installations: recreational facilities, dispensaries, enlisted quarters, additional officers' housing, and mess halls.

In some cases, the Navy contracted with civilian architects; in others, naval personnel did the planning. The installations planned during this period illustrate the use of community planning to organize new installations in a cohesive, functional manner. As in previous eras, the Navy Department did not provide standardized plans, and allowed individuality in building design. Most new construction was located on the West Coast; naval construction in California was dominated by the use of regional Spanish Mission revival architectural styles. Georgian Colonial Revival dominated East Coast and Pacific Northwest residential and administration construction. Industrial construction at shipyards continued the use of modern, functional architecture that had begun around World War I.

Two West Coast training installations illustrate the emergence of community planning and Spanish Mission revival architecture. The Navy Department appointed Bertram G. Goodhue, the noted architect responsible for the Navy's North Island Air Station in San Diego, as "consulting architect". Goodhue's experience in planning large institutions such as universities and in the Spanish Revival style, as at the Panama-California Exposition in San Diego, greatly influenced Southern California naval facilities.[54]

Between 1922 and 1924, the Navy constructed a training center in San Diego, California. J. S. Morley, local superintendent of Balboa Park, site of the Panama-California Exposition, developed the master plan and landscaping. The Bureau of Yards and Docks designed the buildings, utilizing some of the same architects who had worked on the plans for the Naval Air Station at North Island. The influence of both Bertram G. Goodhue and Irving Gill, a prominent modern architect from San Diego, are evident in the sparsely ornamented "simplified Mission" style of the original buildings (Figure II-27).[55]

The Marine Corps Recruit Depot at San Diego, California, also illustrates the prevalence of the Spanish Colonial Revival/Mission architectural style in the San Diego region. Designed to be the "premier military location in the southwestern United States," the Navy retained Bertram G. Goodhue as the architect in 1918. Goodhue's plan, though reduced and slightly modified by the Bureau of Yards and Docks, is the essential design of the recruit depot. The plan follows a formal organization of space, with strong visual axes (Figure II-28). Goodhue's design philosophy influenced the landscape plan and building designs for all major naval installations built in the San Diego area during this period. The influence of San Diego minimalist architect Irving Gill also can

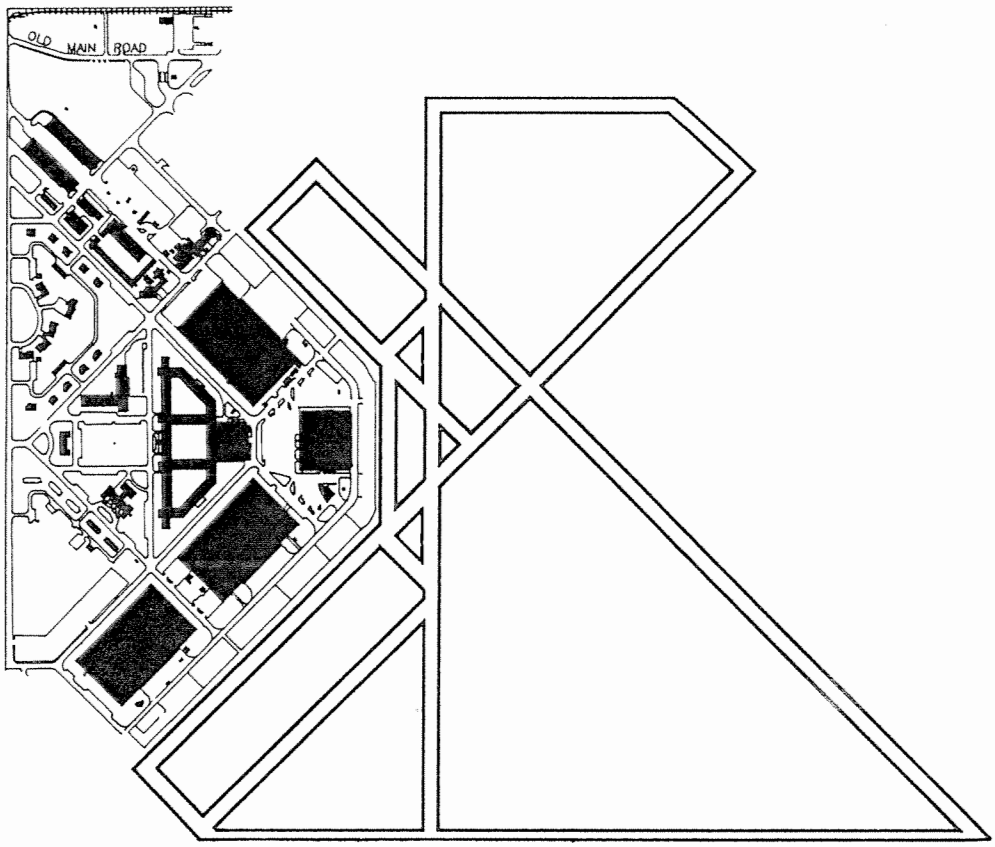


Figure II-25. Barksdale AFB, *below*, with line of hangars along single runway and Chanute AFB, *above*, with intersecting, multiple runways.

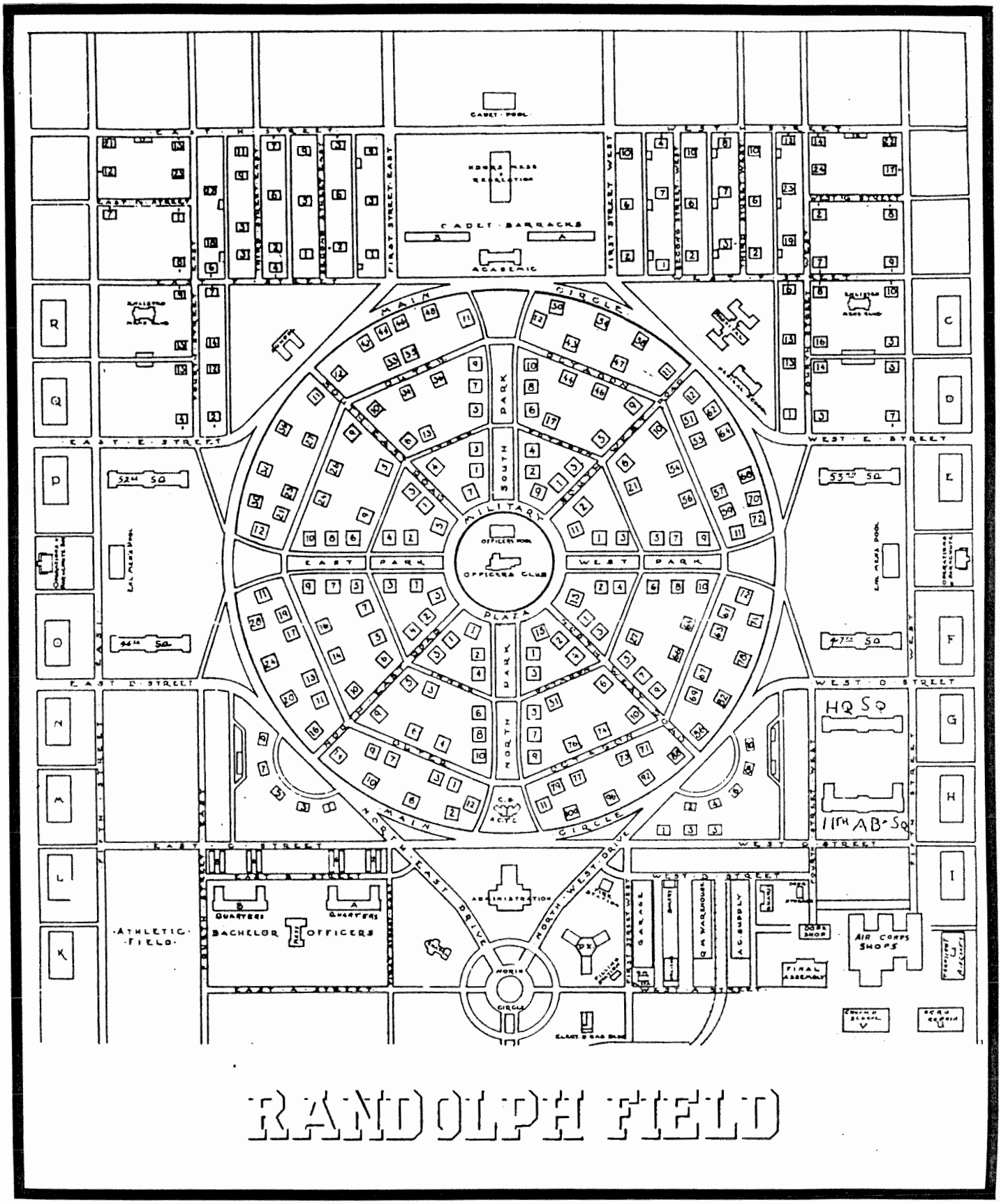


Figure II-26. Plan of Randolph AFB, Texas, ca. 1928.

Figure II-27. Barracks constructed in 1924 (Bldg. 26, Naval Training Center, San Diego, California).

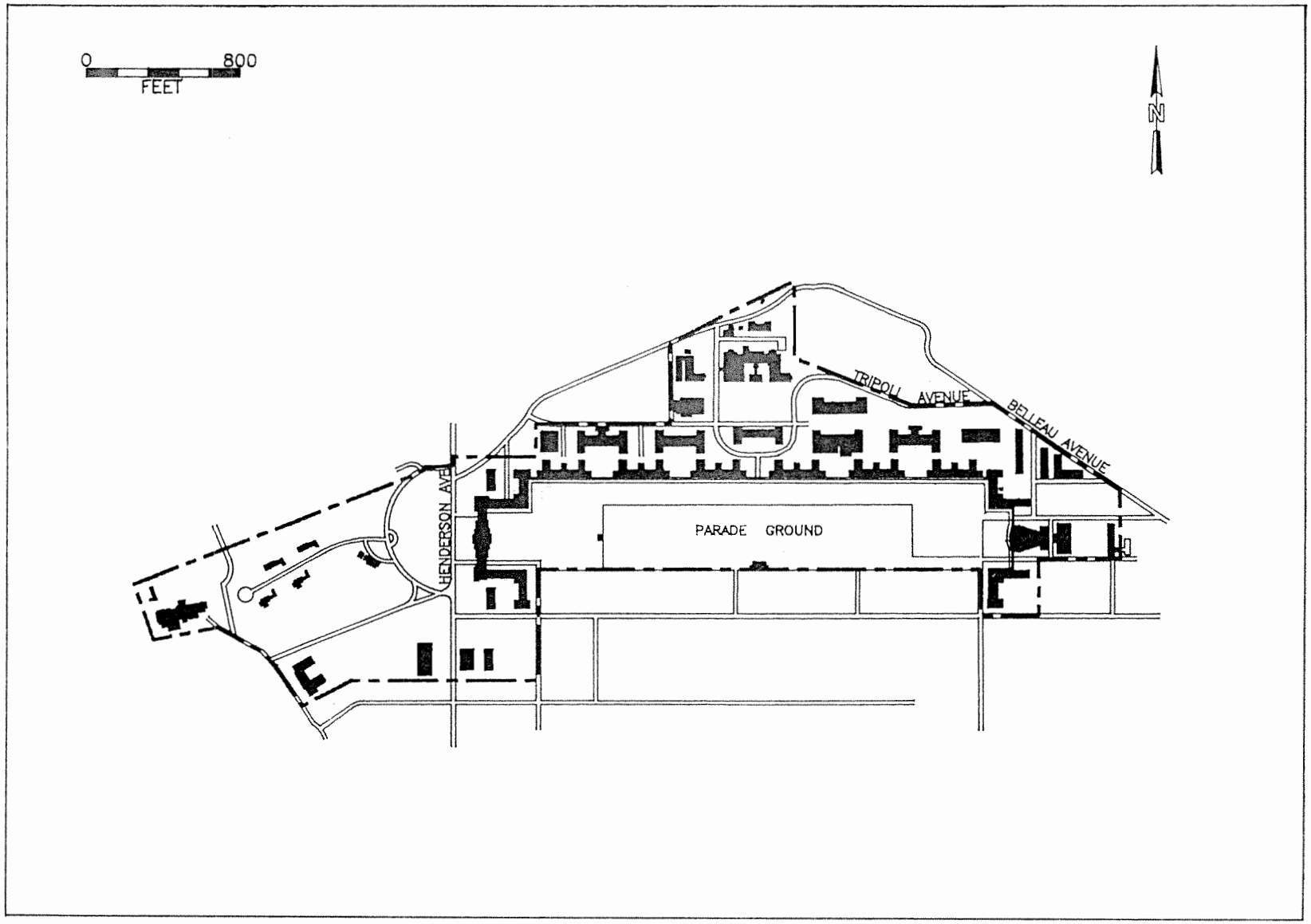


Figure II-28. Plan of Marine Corps Recruit Depot, San Diego, California, constructed between 1921 - 1926.

be discerned in the absence of the florid, late Baroque ornamentation that had characterized Goodhue's Spanish Colonial Revival exposition buildings.[56]

The Navy and Marine Corps also expanded training installations on the East and Gulf Coasts. The Navy expanded its World War I-era aviation training facility at Pensacola, Florida. The new training complex surrounded the original shipyard. The training station included barracks, classroom buildings, an auditorium, officers' housing, recreational facilities, a training airfield, and support buildings. The buildings were constructed in the Georgian Colonial Revival architectural style.

After World War I, the Marine Corps transformed its temporary facility at Quantico, Virginia, into a permanent station. In 1923, Washington, D.C., architect, Glen Brown designed a master plan for the new Quantico installation; the plan was not implemented due to its high cost. Instead, the installation evolved by combining two planning traditions. Suburban planning methods were used when curving streets were laid out, to take advantage of the natural topography. Officer's housing lined these streets. The barracks and administration area follows a more formal arrangement, with buildings in a staggered relationship similar to that found at the San Diego Marine Corps Recruit Depot, but without a linking arcade between the buildings. Two different Colonial Revival styles were used: red brick Georgian Revival for the administration, barracks, and multi-family housing (1935 - 1940); wooden-frame Dutch Colonial Revival for the officer's housing (1918 - 1923).[57]

In contrast to its housing and support buildings, the Navy continued to build unadorned, modern industrial structures, without historical references, that exploited the structural technologies of the day. Huge dirigible hangars dominated the Navy's two lighter-than-air aviation facilities, Lakehurst, New Jersey, and Moffett Naval Air Station, California. The steel-frame Hangar 1 at Lakehurst was constructed in 1921 and measures 961 ft in length. The 1,140 ft-long hangar at Moffett Naval Air Station, constructed in 1933, was also steel-frame, and featured curved, steel doors (Figure I-13). The hangar at Moffett stood in contrast to the Spanish Mission revival housing and administration buildings of the air station.

Construction at shipyards consisted primarily of industrial buildings, either of steel-frame or of reinforced concrete construction. During the late 1930s, federal public works projects funds enabled the Navy to modernize shipyards and plan for future expansion. Functional designs with minimal architectural ornamentation characterized inter-war shipyard construction (Figure II-29). In many cases, the 1930s buildings dwarf previous shipyard construction. When war threatened Europe in 1939, the Navy greatly expanded its shipyards, using a mix of permanent masonry construction and modular construction.

During the inter-war years, historical revival styles dominated military construction, particularly residential and other personnel support buildings. Industrial buildings continued the pattern established around World War I of following functional designs rather than the revivalist designs of industrial structures common during the nineteenth century. By the end of the 1930s, military architects designed and built a few examples of cantonment architecture that deviated from the standard revival styles. The streamlined, Art Deco-influenced residential designs at Kelly AFB, Texas, and McClellan AFB, California, both aviation depots that received major construction funding in 1939 and 1940, are examples of this departure. During the Protective Mobilization phase immediately before the United States' entry into World War II, the military continued permanent construction, concentrated construction activities at high priority installations, and forewent private architects in favor of the military's own design services. The imprint of regional design and community planning favored by all of the services before the Second World War left a major imprint on military installations nationwide.

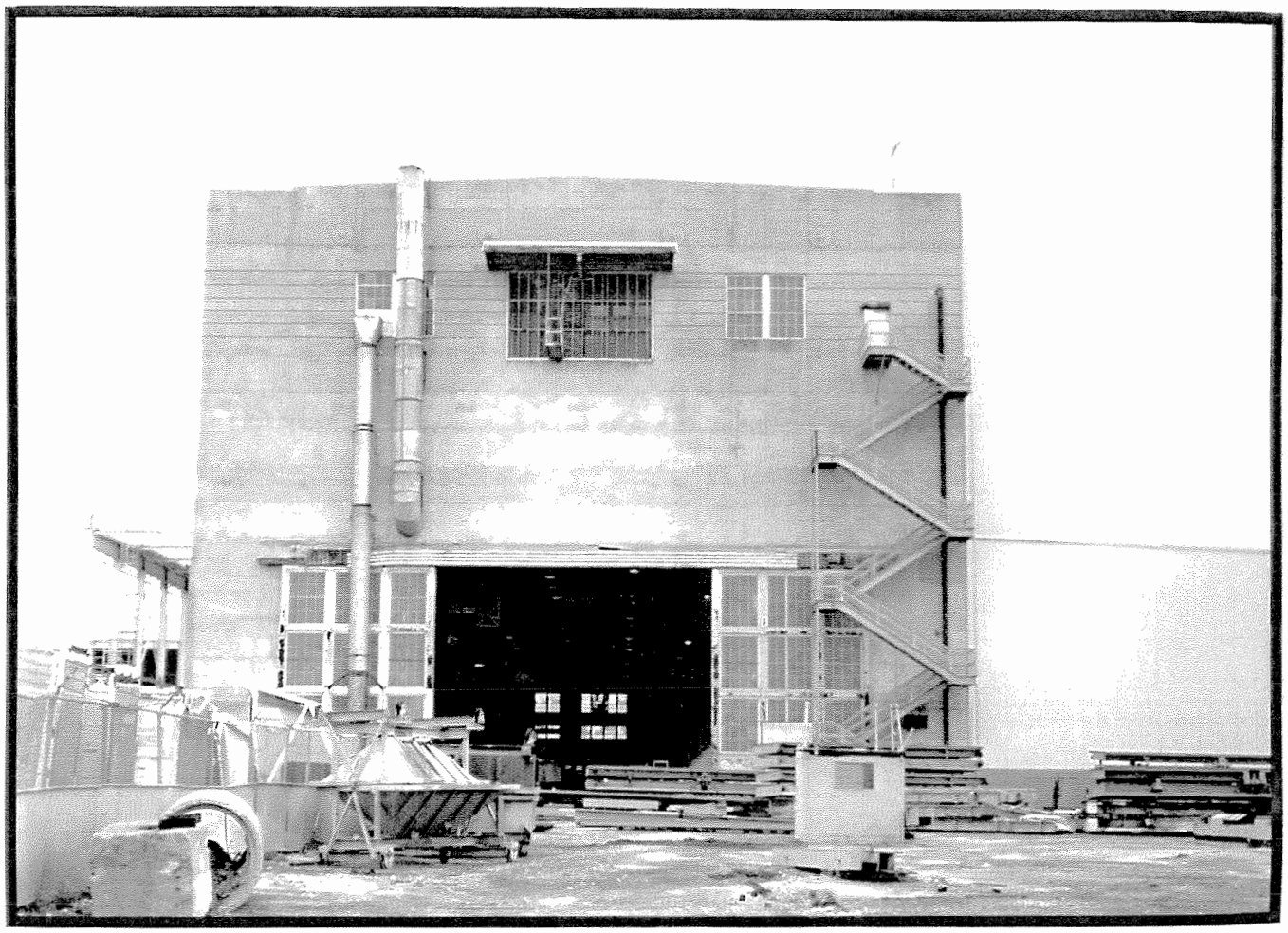


Figure II-29. Reinforced-concrete shipway constructed in 1937, with public works funding (Building 2A, Naval Base Charleston, South Carolina).

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record examples where the Naval Constructor in charge of ship construction also designed buildings at the Charlestown (Boston) Navy Yard, Massachusetts.

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CHAPTER 5
TECHNOLOGY

United States military history contains innumerable examples of the application of new technology. Despite some notable miscalculations about the importance of technological innovations, the services normally have recognized the significant advantages of superior weapons and equipment. The pace of technological changes increased steadily during the late nineteenth and into the twentieth century. Technology with direct military applications includes weapons, permanent fortifications, warships, and military aircraft.

This discussion excludes technology that is applied primarily to civil uses. Examples of installation housing or utilities, therefore, are not discussed here. Transportation and communications technology that have direct tactical applications are discussed in portions of this report that specifically address transportation and communication.

Weapons and Ammunition

Between 1790 and 1940, most military weapons were either small arms, Army artillery, or Navy artillery. Types of small arms included muskets, rifles, pistols, and machine guns. Army artillery usually is divided into three categories: (1) the cannon, a low trajectory, direct-fire weapon; (2) the howitzer, a medium trajectory, indirect-fire weapon; and, (3) the mortar, a high trajectory, indirect-fire weapon. During this time, Navy artillery changed from small guns to massive weapons with a corresponding increase in range, yet they continued to fire at a low trajectory.

Barrels for any type of gun could be either smoothbore or rifled. A rifled barrel contains spiraled grooves that cause the projectile to spin as it passes through the barrel. The spinning motion gives the projectile greater accuracy. It also allows the gun to fire a cone-shaped projectile, which greatly increases the weight of the projectile. For small arms, the smoothbore musket was commonly used until the 1850s, when the Americans adopted the minie ball. Although rifled artillery existed during the 1860s, it was not widely used until after the Civil War. Both the Army and Navy have manufactured their own weapons and ammunition. They also relied heavily on contractors, but they believed in producing at least a large portion of their own material.

Production of weapons within the Army came under the supervision of the Ordnance Department. Its installations consisted of armories and arsenals. Springfield Armory, Massachusetts, was the earliest and most important armory. The facility traced its history to the American Revolutionary War, and received Congressional authorization as an armory in 1794. It became the principal production facility for muskets, rifles, and other small arms. The Army operated another armory at Harper's Ferry in present-day West Virginia until it was destroyed during the Civil War. Arsenals could be used for manufacture, repair, or storage of ordnance. When used for manufacturing, arsenals concentrated on secondary ordnance items, such as cannon carriages or kits for artillerymen.

One of the significant contributions of the Army's Ordnance Department was the use of standardized techniques and interchangeable parts in the production of small arms. The Springfield Armory was especially important in pioneering standardization. In 1818, workers at Springfield developed a system of gauges to measure parts. When these same gauges were used at the Harper's Ferry Armory, weapons could be produced from either center with interchangeable parts. Springfield proved to be a better location for experimenting with new techniques, for the workers at Harper's Ferry tended to resist standardization.[1]

The Washington Navy Yard began its long association with naval ordnance during the 1820s, when the Navy constructed an ordnance laboratory there. In 1845, the yard began to make fuses at its laboratory. Lieutenant John Dahlgren established an experimental battery there in 1847, which enabled him to design his bottle-shaped cannon. Design of heavy artillery required that the weapon fire the largest projectile possible, with a minimum barrel weight, and that the barrel be strong enough to withstand the force of the explosion. Dahlgren concluded that the greatest stress on the barrel came near the breech. While assigned to the Washington Navy Yard, he designed a bottle-shaped gun that was thick at the breech, and thinner near the mouth. The new "Dahlgren Gun" could fire a larger projectile than other models, without an increase in the weight of the barrel. In 1854, the Navy began manufacturing heavy guns at the Washington Yard. Until well into the twentieth century, the yard would be vital to the Navy's ordnance manufacturing.[2]

Artillery production for both services improved in 1883, when Congress prodded the War and Navy departments to establish a joint Gun Foundry Board, which recommended the creation of an Army Gun Factory. Watervliet Arsenal was designated as the Army's first gun foundry. Four years later, it began manufacturing the first Army artillery. It continued to perform that function into the twentieth century. The Army/Navy Gun Foundry Board recommended that the Washington Navy Yard be used as the Navy's gun factory, and the Secretary of the Navy concurred. By 1892, the Washington Yard could produce guns with a 13-inch diameter, and by 1898, it was one of the largest ordnance factories in the world. It continued to make heavy guns through World War II.[3]

Army ordnance officer Thomas J. Rodman further improved heavy artillery with his experiments on the cooling process of the barrel. He discovered that when the barrel is allowed to cool normally, the outside will cool first, causing an outward stress on the barrel as the outside contracts while the inside remains hot. Rodman remedied the situation by cooling the inside of the barrel with water, while heating the outside of the barrel. With some reenforcing hoops at the heaviest stress points, the "Rodman gun" could fire an even larger projectile than the Dahlgren gun.

During the second half of the nineteenth century, the military also began to study improvements in powder. Until that time, black powder was the most commonly used propellant. In addition to producing a heavy smoke, black powder also burned rapidly, so rapidly that the explosion ended before the round left the barrel. European armies and navies recognized the limitations of black powder and began to experiment with nitrate compounds that burned more slowly with less smoke. The U.S. Navy declined to adopt formulas developed by Alfred Nobel or Hiram Maxim because these formulas contained nitroglycerin, which deteriorated rapidly and tended to explode prematurely in a hot barrel. Chemists at the Navy Torpedo Station in Newport, Rhode Island, produced their own nitrocellulose-based powder, which they persuaded E.I. du Pont de Nemours & Company to manufacture.[4]

The Navy began to produce its own powder at Torpedo Station in 1892. The Navy moved its powder plant to its proving ground at Indian Head, Maryland, in 1900 because Newport was too crowded for the production of explosives. The Indian Head plant differed from Torpedo Station in that it produced explosives on a large scale. In fact, it was the Navy's first large-scale chemical production facility. During World War I, the War Department opened two of its own smokeless powder plants. The Nashville, Tennessee, plant was one of the largest in the world; a second plant at Charleston, West Virginia, supplemented the Nashville plant.[5]

The Army also invested in powder production. The Army established Picatinny Arsenal near Dover, New Jersey, in 1880 as a depot to store powder, projectiles, and explosives both for reserve and for issue. In 1907, the Army constructed a smokeless powder plant at Picatinny and

in 1911, established a school for instruction in chemistry, explosives, and interior ballistics. Between 1919 and 1920, the Army established a small experimental ammunition plant at Picatinny, transforming it into a manufacturing arsenal. During the inter-war period, Picatinny was the Army Ammunition Arsenal for loading bombs and projectiles above .50 caliber; manufacturing and loading pyrotechnics; for manufacturing smokeless powder; for assembling fixed ammunition above .50 caliber; and, for performing Ordnance Department laboratory work.[6]

Military interest in smokeless powder and other explosives also produced disasters that had a significant effect on the history of technology. For example, until 1926, the Navy Department stored high explosives at its Lake Denmark Magazine, adjacent to Picatinny Army Arsenal. In that year, an electrical storm caused an explosion that caused "sympathetic explosions" at nearby buildings. Nineteen people died in the accident, and towns as far as three and one-half miles away received severe damage. This incident resulted in the implementation of stricter regulations governing high explosives, including protection from electrical storms, magazine construction requirements, and limitations on the quantities that could be stored in any one location.[7]

As the United States developed more accurate artillery, it discovered a need for high-quality optical instruments. Modern artillery required optical-quality glass for sighting mechanisms and ordinary binoculars. At the beginning of World War I, the United States depended on Germany for most of its optical glass. The loss of that source of supply for the critical component forced the United States to develop its own industry. With the aid of the Bausch & Lomb Optical Company in Rochester, New York, the War and Navy Departments developed new methods of producing optical glass.[8]

Military ordnance also required facilities to test new weapons. Testing included both extensive experimental work on new designs, and proof-firing of all new artillery. Work conducted at Army and Navy proving grounds required the most precise measurement devices for their time and other technological developments for improving military weapons.

Until 1874, the Army test-fired its new artillery pieces at Ft. Monroe, Virginia, but that post only had a 1,000-yard range. In that year, the Army converted an unnecessary coastal defense fort into a new proving ground at Sandy Hook, New Jersey. The proving ground contained facilities for test-firing weapons, as well as chronoscopes, which measured the velocity of projectiles. As the Army improved its coastal defense artillery during the 1880s, Sandy Hook Proving Ground played a vital role in testing the new weapons. In 1918, Aberdeen Proving Ground, Maryland, replaced Sandy Hook as the Army's proving ground, because of Aberdeen's greater expanse of real estate.[9]

Following the success of the Army's Sandy Hook Proving Ground, the Navy established its own proving ground at Annapolis, Maryland, during the late 1870s. Through the early 1880s, the Annapolis facility performed its missions of "testing of guns, ascertaining the best composition and temper of steel for armor-piercing projectiles, and the resistance of steel and other armor plates, the measurement of chamber pressures in the different classes of guns; the employment of gun cotton in armor-piercing projectiles, and various other very important operations."[10] However, Annapolis was not a good location for firing heavy weapons; ships and pleasure boats in the Chesapeake Bay hindered gunnery practice. Moreover, a hotel was located halfway down range. In 1889, the Navy acquired an isolated tract of real estate at Indian Head, Maryland, that proved to be a far superior location for its purpose. The Indian Head site was remote from developed areas and bordered the Potomac River, which offered a large test-firing area and access to the Washington Navy Yard.[11]

Workers at Indian Head studied the ballistics of naval guns through a wide range of experiments. They examined the physical characteristics of shells, the penetration of armored plates, new types of fuses, types of explosives for shell fillers, gun mechanisms, and anti-aircraft guns. They also proof-fired new lots of smokeless powder to determine the amount that should be used in gunnery. They even experimented with new fire extinguishers and rockets to send tow lines to vessels in distress. In 1918, the Navy added the Dahlgren Annex, located on the Virginia side of the Potomac River, to the Indian Head facility. By 1921, most gunnery testing was moved to Dahlgren to take advantage of its more isolated location.[12]

Another type of weapon was the torpedo. During the second half of the nineteenth century, any type of underwater explosive device was called a torpedo. The term "torpedo" at first referred to what is now called an underwater mine. European navies, however, began to experiment with ways to direct the torpedo over a reasonable distance. The result was the "automobile torpedo," which could be employed against surface ships.

In 1869, the Navy established a torpedo station at Newport, Rhode Island, to conduct experimental work with torpedoes. Beginning with a staff of three members, the station became one of the most important of the Navy's ordnance facilities. In addition to the development of torpedoes, the station also conducted work on shipboard electrical systems, torpedo countermeasures, and new explosives. As noted above, the Navy began the development of smokeless powder at Newport. During World War I, members of the Torpedo Station also developed depth charges to attack German submarines. The adjacent waters of Narragansett Bay were used to test two new types of boats; the torpedo boat, a small boat designed to fire torpedoes at larger ships, and the submarine.[13]

Another new weapon of the early twentieth century was the tank. The tank appeared in World War I as part of an effort to break the stalemate of trench warfare. Slow speed and short range limited the usefulness of the earliest versions, but under the correct conditions, their shock effect could be decisive in supporting an infantry attack. Lacking its own tanks, the United States used French models during World War I.

After the war, development of armored warfare in the United States suffered from both a lack of funds and a constricted vision of the possibilities of tanks. As was the case with other types of equipment, Congress was reluctant to pay for new weapons at a time when war seemed unlikely. Congressional economizing might have been overcome if senior officers had a better appreciation of the potential of armored warfare. Having used the tank in support of infantry assaults, Army generals did not recognize how improved range and reliability of tanks could make them a potent weapon independent of the infantry. When two relatively junior officers, Dwight D. Eisenhower and George S. Patton, tried to publish articles extolling the uses of tanks, both were reprimanded severely for departing from Army doctrine.[14]

Armored doctrine continued to progress slowly. Its most important development came in 1928, when the War Department organized a Provisional Mechanized Force at Camp Meade, Maryland, under the direction of an energetic Major Adna Chaffee. Chaffee's experiments were just beginning to demonstrate the uses of armor as distinct from either infantry or cavalry, when the new Chief of Staff, Douglas MacArthur, disbanded the force. MacArthur argued that each branch should be allowed to develop armored warfare in its own way, thus dividing responsibility for armor between the infantry and cavalry. His decision caused armored doctrine and material to languish during the 1930s, especially with regard to the development of heavy tanks.[15]

Following the disbanding of the Provisional Mechanized Force at Camp Meade, both the infantry and cavalry experimented with tanks. The cavalry responded by designating the 7th Cavalry Brigade at Ft. Knox, Kentucky, a mechanized cavalry force. The unit preserved some

interest in armored warfare within the Army despite the preference of traditional cavalry leaders for the horse. Officially, the brigade was confined to traditional cavalry missions of reconnaissance, raiding, and screening, but its commander, Chaffee, developed it into a combined arms force capable of conducting sustained combat. With the addition of infantry units during the 1940s, the 7th Cavalry Brigade became the forerunner of modern armored cavalry.[16]

Fortifications

The series of coastal fortifications around the principal harbors and Navy yards is an impressive example of military engineering in the United States. These fortifications were intended to protect the United States from a foreign attack by preventing any enemy from gaining a harbor that could be used as the base for an invasion. Coastal defenses, which began with simple earthworks and small batteries of cannon, had evolved into large, complex masonry fortifications by the eve of the Civil War. With rapid improvements in heavy artillery during the late nineteenth century, coastal defenses relied less on walled forts and more on elongated batteries.

Coastal defenses prior to 1860 can be divided into three distinct classes; the First, Second, and Third Systems of forts. The First System originated out of the threat of war with France during the 1790s. Many of the forts were earthworks, although some, like Ft. McHenry in Baltimore, consisted of a combination of masonry and earthen walls. Recognizing the limitations of its coastal defenses, Congress authorized a second set of forts in 1807. Many of the forts built in the Second System were constructed of a combination of masonry walls with earth filler, though most consisted of earthen walls and timber. Some, such as Castle Williams on Governors Island, New York, were entirely masonry, with multiple tiers of guns.

During the War of 1812, the British successfully attacked Washington, D.C., but were unable to capture Baltimore's Ft. McHenry. The differing fates of these two cities convinced the U.S. government of the wisdom of masonry coastal defenses. Consequently, Americans undertook the construction of the Third System of coastal forts. Without a specific threat of war, Congress appropriated money reluctantly. Therefore, the Third System proceeded slowly from 1816 to 1860. The lack of urgency allowed the Army to plan its coastal defenses with greater care. Military engineers Simon Bernard and Joseph G. Totten visited the sites to be defended, and developed comprehensive plans with coordinated fields of fire. One of the most important developments of the Third System was the use of all-masonry fortifications. The use of masonry allowed the engineers to construct casemates, or gun portals, within the walls. Primarily intended to protect gunners during an attack, casemates also allowed engineers to multiply the number of guns at a single fort by placing tiers of guns inside the walls. Thus, this new series of forts could produce a formidable array of firepower.[17]

An 1836 report to Congress showed 38 coastal fortifications, with an average of 70 guns per fort. Ft. Monroe, Hampton Roads, Virginia, was the largest of these forts with 301 guns; with Ft. Adams, Newport, Rhode Island, second largest at 293 guns, and Ft. Pickens, Pensacola, Florida, third at 235 guns. Most forts contained between 15 and 100 guns, although forts guarding the smaller cities might be fortified with less than 10 guns. Ft. Hale, New Haven, Connecticut, was the smallest on the list, with only 6 cannon. Sixteen of the forts contained casemated guns, while the remainder held only mounted guns on the ramparts (barbette guns).[18]

At the time it was designed, the Third System was capable of defending U.S. harbors against any foreign navy. By the time it was completed, it had become obsolete. The forts were designed to battle wooden sailing ships armed with smoothbore cannon. The slow speed of the sailing ships made them easy targets, while the ships' smoothbore cannon could inflict little damage to a fort's masonry walls. By the 1860s, however, modern navies had developed steam-

powered ships that could bypass a fort with acceptable losses. Equally important, most navies also acquired rifled cannon, which could fire a cone-shaped projectile. The cone could inflict far more damage to a fort's masonry walls because the cone had a much greater mass than a spherical cannon ball. The success of the Union Navy in capturing southern ports during the Civil War demonstrated the inadequacies of masonry forts.[19]

Despite the generally recognized inadequacies of the Third System, the government made little effort to improve the coastal defenses until the 1880s. The American people were unwilling to spend much money on the military, having just recovered from the Civil War and enormous debt. By the 1880s, however, conditions of coastal forts had deteriorated to the point that the Navy complained about the Army's inability to defend the principal Navy yards.[20] In response, President Grover Cleveland appointed a board of experts to study the coastal defense system and make recommendations for its improvement. This became the so-called "Endicott Board," named after its president, Secretary of War William Endicott. Upon the board's recommendation, the Army installed batteries of heavy artillery along the coastline at strategic points. These batteries no longer had the appearance of a classic harbor defense fortification; instead, they consisted of heavy guns that were placed behind a parapet for shelter and dispersed for greater protection.[21]

The defenses of the Endicott period emphasized the greatly increased power and distance of modernized artillery. For example, during the Civil War era, a 10-inch Rodman gun could fire a 123-pound projectile about 4,000 yards; by 1890, a 10-inch rifled gun could fire a 604-pound projectile 12,300 yards. To protect these powerful weapons, coastal batteries developed disappearing gun platforms. These platforms were raised to the level of the wall prior to firing, and then used the force of the recoil to lower the gun as it fired. The soldiers could then reload the gun behind the protection of a wall, and raise it again just prior to firing. Other coastal batteries employed mortars or underwater mines (torpedoes). In 1905, another board, chaired by then Secretary of War William Howard Taft, recommended further improvements in the coastal defense system, including the installation of searchlights and electrical communications.[22]

From World War I to 1937, changes to coastal fortifications consisted largely of improvements to the existing facilities. Where feasible, the Army added new guns to existing batteries, including some naval guns that became excess after the Naval Disarmament Treaty of 1922. For protection, the Army relied on dispersion of the guns and supporting facilities, placing the 16-inch guns as far as 1,000-thousand feet apart, and connecting the guns with small railroads. The most significant addition to coastal defenses was the addition of anti-aircraft batteries.[23]

In 1937, the Army built a new type of battery near San Francisco, which became a prototype for World War II fortifications. This battery contained two 16-inch guns protected by enormous casemates and a thick combination of reinforced concrete and earth. Interconnecting ammunition facilities also contained overhead protection. This new battery was designed to withstand both an air attack and bombardment by a battleship.[24]

Although the Army terminated its harbor defense mission shortly after World War II, the impressive system of harbor fortifications formed a vital part of the U.S. national defense network. The enclosed forts of the antebellum era and the dispersed batteries of the Endicott and later periods demonstrated the application of military engineering to seacoast fortifications.

Warships

Between the years 1790 and 1940, the Navy used a combination of contractors and Navy yards to construct its ships. Contractors usually built the larger portion of ships, but the Navy Department believed in maintaining a capability to construct its own ships. Moreover, the Navy

wanted to maintain a force of skilled workers, and ship construction enabled the Navy to offer steady employment to its workers.

With the establishment of a navy during the late 1790s, the United States realized that it must also have facilities to construct, repair, and refit its fleet. Normal commercial shipbuilding facilities were too small to construct a warship. In 1800, Congress authorized the acquisition of the first six Navy yards at Portsmouth, New Hampshire; Charlestown (Boston), Massachusetts; Brooklyn, New York; Philadelphia, Pennsylvania; Washington, D.C.; and Gosport (Norfolk), Virginia. These yards were used to construct new ships; to produce secondary items of supply, such as rope or anchors, to repair ships; and to resupply the fleet.

One of the most important features of a Navy yard was the dry dock, which was used to repair ships. The first excavated dry docks were finished at the Charlestown and Gosport Yards in 1833. Construction of a dry dock was difficult because it required digging a hole deeper than the water level. In order to prevent the upward hydrostatic pressure from destroying the walls, the dry dock required heavy granite sides up to 10 feet thick. To avoid the difficulties of an excavated dry dock, Congress pressured the Navy into building a few floating dry docks. These were usually wooden structures that would float upwards in response to hydrostatic pressure. Although the floating dry docks were easier to construct, excavated dry docks were more durable. The Gosport dry dock continued in service at least through World War II.[25]

Steam power came slowly and hesitantly to the U.S. Navy during the antebellum period. The first steam-power vessel was the *Fulton*, a twin-hulled boat with a paddle wheel between the two hulls. Constructed in 1814, this boat was designed for coastal defense, not for cruising on the ocean. The United States did not launch another steam power vessel until the *Fulton II* in 1837. The first sea-going steam ships, the *Mississippi*, and the *Missouri*, were completed in 1842.[26]

These earliest steam ships were all paddle-wheel vessels, which meant they were propelled by a large wheel mounted on the side. They also contained a full rigging of sail, and normally moved under sail. The steam engines consumed so much coal that they were used only in an emergency or in battle. Even in battle, the paddle wheel ship offered a mixed advantage. Although the steam engines enabled the ship to cruise against the wind, the large wheels were vulnerable to enemy fire.

The *Princeton*, completed at the Philadelphia Navy Yard in 1844, resolved the problems of a paddle wheeler. The Swedish naval engineer John Ericsson designed the *Princeton* with a screw propeller entirely underwater, thus protected from enemy fire. Thereafter, the Navy constructed ships that could use sails for normal cruising, and steam for emergencies and fighting. The Washington Navy Yard began to manufacture marine steam engines in 1842 and continued to do so through 1875. It was the only yard to make steam engines before the Civil War.[27]

Ironically, the *Princeton* also was the scene of a famous Navy accident on February 28, 1844, that hindered the technological progress of the Navy. The ship was equipped with a 12-Inch cannon called the "Peacemaker." During a demonstration cruise with the President Tyler and Secretary of State Able Upshur aboard, the cannon exploded. Upshur and five others were killed. Until shortly before the accident, Upshur had been Secretary of the Navy, where he had encouraged the construction of the *Princeton* with its new weapon. Recriminations about the accident caused Ericsson to withdraw his services from the Navy until the Civil War, when he designed the ironclad *Monitor*.[28]

Gosport Navy Yard, near Norfolk, Virginia, played a crucial role in development of Ironclad warships during the Civil War. At the beginning of the war, the Union Navy abandoned the yard,

and attempted to destroy as much of it as possible. However, they could not destroy the excavated dry dock. The Union Navy also left behind the partially destroyed steam frigate *Merrimack*. Although burned to the waterline, the hull and steam propulsion system were still intact. The Confederate Navy used the Gosport dry dock to convert the ship into the ironclad *Virginia*. The Confederates added an iron superstructure, and mounted ten guns on the ship. The new ship threatened the wooden fleet of the Union Navy.

In response to this danger, Ericsson once again offered his services to the Navy. He designed an entirely new type of warship: it had a flat deck with an extremely low free-board, and was entirely protected by iron plating. Its weapons consisted of two Dahlgren guns, mounted on a revolving turret. Like the *Virginia*, it relied on steam engines for power. The hastily-constructed warship, named the *Monitor*, rushed south and protected the Union fleet from the *Virginia* in a battle near Hampton Roads.[29]

The success of the *Monitor* inspired a class of imitation vessels. The Union Navy continued to build similar vessels called monitors. In 1874, the Navy began to build another series of monitors that took so long to complete that they became amalgamations of changing naval technology. The Navy avoided specific Congressional appropriations by taking old ships and bringing them to a yard for "repairs;" these "repairs" constituted entirely new ships. Although their low silhouettes offered some protection against enemy guns, the ships were unstable in heavy seas. Nonetheless, they were favored as an inexpensive means of coastal defense through the time of the Spanish-American War. They remained as auxiliary vessels into the twentieth century.[30]

For all of their limitations, the monitors remained one of the few innovations in naval technology between the Civil War and the 1880s. For the most part, the U.S. Navy consisted of aging wooden ships. The ships that did have steam engines used them only in emergencies, relying on sail power to conserve coal. By the early 1880s, the Navy had deteriorated to the point where the Secretary of the Navy called it "a subject of ridicule at home and abroad."[31]

Even when better technology was available, the Navy would not or could not implement changes. In 1869, the Navy built a new steam powered ship, the *Wampanoag*, that set a new speed record of 16.75 knots in rough water, which would have made it a formidable commerce raider. Yet a Navy board condemned the ships as "scarcely more than naval trash," and Admiral Porter followed the boards' action with orders that coal could be consumed only in emergencies.[32] In part, these actions were caused by concern that the amount of coal consumed, plus the unreliability of steam engines, made sail a better bargain. In fact, the British Admiralty also had restricted the use of coal. The resistance of Navy officers to steam engines also reflected doubts about the intrusion of technology into their domain, including a general hostility towards steam engineering officers.[33]

The beginnings of a modern navy came in 1883 when Congress authorized the construction of three steel cruisers, the *Atlanta*, *the Boston*, and the *Chicago*, more popularly known as the ABC cruisers, plus a steel dispatch boat called the *Dolphin*. Because the cruisers' thin hulls could not deflect a round, engines and vital areas were protected by the coal bunkers. They were designed to use sail power for normal cruising, but could rely on steam power during battles. These new ships were followed by larger battleships, such as the *Maine*, the *Texas*, the *New York*, and the *Olympia*. These ships required small escorts ships and auxiliary vessels, especially colliers.[34]

Construction of these few ships demonstrated how deficient the Navy had become in adapting to modern naval technology. The contract had been awarded to a prominent Republican. When the Democratic Cleveland administration came to power in 1885, the new

Secretary of the Navy, William Whitney, refused to accept the *Dolphin*, citing deficiencies in meeting the specifications. The contractor, who was building the other new ships, was forced into receivership, thus halting the construction. When the Navy attempted to complete the ABC cruisers at its own yards, it discovered that none of its facilities could build a modern warship. The Navy was forced to complete the ships at the contractor's facility, under the supervision of Navy engineers.[35]

The shore establishment not only had demonstrated its inability to construct a modern warship, but the production of these ships also had displayed shortcomings in designing ships and administering contracts. The final hull design of the *Dolphin* was completed only hours before the opening of bids. Afterwards, the constant changes in contract specifications produced delays and legal problems for the Navy. The experience caused Whitney to declare his intention to avoid future changes in contracts. "It is the desire of the department to avoid the long delays in the construction of ships now in process, arising from the making of changes in the plans after the letting of the work. It is believed that careful attention to details at the outset will prevent this harassing difficulty."[36]

During the 1890s, the Navy steadily improved its ability to construct and repair modern warships. It added new stone and wooden dry docks to its yards, and made other improvements. By 1903, the New York Yard undertook the construction of a first-class battleship, the *Connecticut*. For a facility that previously had not constructed a battleship, this was a complicated operation. The ship required hundreds of tons of steel plate to be riveted into frames, precise steam engines, crew quarters, and fittings for the latest weapons and equipment. The New York Yard's ability to complete such a difficult task demonstrated that the Navy yards could now compare favorably with any private contractor.[37]

Throughout the twentieth century, the sophistication of Navy facilities for ship construction and repair steadily increased. The Bureau of Yards and Docks improved the capacity of the ships "ways" or the rails on which ships were built. The cranes for placing heavy equipment on ships were particularly noteworthy. When completed in 1919, the crane at the Philadelphia Navy Yard was the largest in the world, capable of lifting 350 gross tons to 141 feet above the pier.[38]

Although the Navy never reached Whitney's goal of avoiding change orders on contracts, it improved its ability to design ships. The Navy selected some of its most talented engineering officers and assigned them to study at foreign schools. In 1900, ship design received a substantial boost with the construction of a one-million-gallon model ship basin at the Washington Navy Yard. Under the direction of Rear Admiral David W. Taylor, the basin was used to test new hull designs to minimize underwater resistance. The basin also was open to private shipbuilders for testing new designs of commercial vessels. With the addition of a wave-making apparatus during World War I, this model ship basin remained in use until 1945.[39]

In developing its ship designs, the Navy contributed to the development of marine engineering. Workers at Navy yards experimented with new types of steam engines that had high-intermediate-, and low-pressure cylinders. The Navy pioneered the use of turbine engines in the United States in order to meet the requirements of battleships. With the installation of turbine engines, the ships' designers needed a way to transfer the comparatively high speed of the turbine to the slow speed of the ship's propeller. They eventually adopted the technique of connecting the turbine engine to an electric generator, allowing the ship to move at different speeds. The fuel oil testing plant at the Philadelphia Yard studied new ways to burn fuel oil effectively, and assisted in the transformation from coal to oil.[40]

The Navy shared much of the resulting technology with the civilian community, improving not only the quality of the American merchant marine, but other sectors of the civilian economy

as well. Navy test facilities at Annapolis and New York inspected commercial products on a cost-reimbursable basis. Members of the merchant marine were offered instruction in the most efficient methods of burning fuel oil at the Philadelphia Navy Yard. The Washington Yard performed experiments in the engineering of shipboard ventilation systems, which were applied to office ventilation. The Navy's demands for large quantities of steel and steel castings financed the improvements in the American steel industry. The Navy began to write standard product specifications before the practice became common throughout the Federal government, and many of the early Federal specifications were adopted from the Navy. The use of standard product specifications simplified contracting and provided a technical language for industries to communicate with each other.[41]

The submarine was such a different type of warship that it posed an entirely different set of engineering requirements. Its construction and design, therefore, became the domain of a comparative handful of Navy officers. Although experiments with the submarine began at the Torpedo Station in Newport, the New London Naval Station and Portsmouth Navy Yard became the most important installations connected with submarine technology. New London became the location of a submarine base and school. Portsmouth was the Navy's principal yard for construction of those submarines built by the Navy. It also was the site of testing and experiments in submarine design.

The first submarine to enter the U.S. Navy was the *Holland*, designed and built by the John P. Holland Torpedo Boat Company in 1900. The company later was reorganized as the Electric Boat Company. By any standard, it was an unimpressive boat. Its small gasoline engine limited the cruising range and presented a fire hazard. The battery cells could leak either hydrogen or chlorine gas. The boat lacked a periscope, so the captain needed to surface frequently to get his bearings. Nonetheless, the Navy continued to acquire new submarines, and submarine design steadily improved. The German Navy demonstrated the potency of the submarine with its devastating attacks on Allied commerce during World War I.[42]

Following World War I, the design of American submarines improved steadily, even if hindered by small appropriations. Engineers agreed that a cylindrical shape provided the greatest strength against water pressure while submerged. An added bridge and conning tower allowed the crew to see for greater distances. Submariners learned to control the depth by controlling the "trim" while the boat was in motion. That is, they adjusted the control surfaces on the side in a manner similar to an airplane. The boat then could be placed in "neutral buoyancy," with a tendency to neither rise nor sink on its own.[43]

The extremely tight space requirements of a submarine required an engine that delivered the most power for the least space and weight. Fortunately for the Navy, the diesel engine began to replace the steam engine on railroads at that time. The Navy worked in conjunction with diesel engine manufactures to produce a workable new engine. Navy subsidies helped to improve the quality of the diesel engine while the new market for diesels lowered the cost to the government.[44]

One of the most important advantages of the American submarine over those of Germany or Japan during World War II was the superior strength of its fittings and components. This advantage came as the result of experimental work performed at the Portsmouth Yard. During the inter-war years, workers at Portsmouth tested the resistance of hull designs to depth charge attacks. They then began to place components into the hulls to be tested. One of the most important tests came when workers discovered that battery cases could crack under the stress of an attack. The result could be fatal to a submarine crew because the battery would leak acid. This difficulty was resolved by the addition of a flexible membrane to the battery casing. Thereafter, the Portsmouth Yard continued testing of components on a systematic basis.[45]

During the late 1930s, the Marine Corps undertook a systematic study of the problems in amphibious assaults on a defended beach, in preparation for a war with Japan. Part of the efforts of the Marine Corps School at Quantico included finding boats suitable for landing Marines under fire. Navy boats proved to be unsuitable during the amphibious maneuvers of the 1930s. Starting in 1937, the Navy and Marine Corps funded research on a shallow-draft boat with a flat bow. It became the Landing Craft Vehicle Personnel (LCVP), and the forerunner of a series of assault boats.[46]

As the U.S. Navy fought through World War II and entered the post-war era, it has relied on the technological sophistication of its warships. In so doing, it has followed a practice begun with the modernization of the U.S. Navy during the 1880s and continued throughout the twentieth century. The Navy's shore installations have contributed to this technological growth through their innovations in ship construction and through their research and development work.

Military Aircraft

One of the most important changes to warfare during the twentieth century is the growth of military aviation. For the Army, Navy, and Marine Corps, aviation began as a means of reconnaissance. It soon grew to become a decisive tactical weapon, both over land and sea.

Military aviation began during the Civil War with the use of observation balloons by the Signal Corps; the Army continued to use balloons through the Spanish-American War and World War I. Military use of heavier-than-air craft did not begin until after the Wright brothers built a workable airplane. By 1907, airplane technology had progressed to the point where the Army invited builders to construct an airplane to Signal Corps specifications.

In September 1908, the Wright brothers began demonstrating their airplane at Ft. Myer, Virginia. The tests went well. The airplane set a 57-minute endurance record, and First Lieutenant (later Brigadier General) Frank Lahm became the first military passenger on an aircraft. On September 17, however, Lieutenant Thomas Selfridge was killed in the Army's first fatal aircraft accident. Although this setback halted testing temporarily, the Army was sufficiently impressed to want more aircraft. It contracted with the Wright brothers for additional aircraft and for flight instruction for its pilots. The Wright brothers opened a school at College Park, Maryland, where they taught Lieutenant Lahm, and others how to fly.[47]

The Army displayed little interest in aviation until 1912. In that year, Congress increased funding for aviation with an appropriation of $125,000.00. The Signal Corps then purchased seven airplanes, and established a semi-permanent flying school at College Park. The school remained there until it was transferred to Rockwell Field in San Diego in 1913. Later in 1913, Congress also authorized an Aviation Section of the Signal Corps with 60 officers, although actual strength rarely exceeded 30 officers. Also in 1913, the Signal Corps developed plans for the creation of an Aero Squadron at Ft. Sam Houston and an aviation school at San Diego, but these plans were not funded until 1915.[48]

Navy aviation began in 1910 when Lieutenant Eugene Ely launched an aircraft from a cruiser in Hampton Roads. Later that year, Lieutenant Theodore Ellyson became the first Navy officer assigned to flight training. By 1911, Navy aviators had landed aircraft on a ship, and had experimented with using a ship's crane to launch a seaplane. Ellyson completed his flight training and became the first certified Navy aviator. Lieutenant Alfred Cunningham received that distinction from the Marine Corps in 1912.

World War I demonstrated the value of military aviation to both land and sea warfare. At the beginning of the war, the European armies discovered that observation aircraft enabled them to detect enemy movements, thus providing a significant tactical advantage. To prevent the enemy from observing their own movements, both sides developed combat aircraft, and aerial warfare began to form. As the war progressed, aviators produced bombers that could reach behind enemy lines to disrupt their support activities. At sea, Allied Navy pilots used airplanes to detect German submarines, using bases in France and the United States.

With this demonstrable value of military aviation, the size of Army and Navy aviation grew phenomenally during the war. Army and Navy aircraft aviation grew from 146 airplanes in 1914 to 13,991 airplanes in 1918. Both services established a network of ground facilities, including flying fields, to support their aviation efforts. These facilities became the nucleus of the Army Air Corps's installations.

Following World War I, the Army, Navy, and Marine Corps continued their aviation programs. Although military aviation remained small in size, aircraft performance advanced remarkably during the 1920s and 1930s. The fabric-covered bi-planes that characterized World War I aviation gave way to metal mono-planes. Engine performance improved for all types of aircraft. Politically, these years were characterized by bitter quarrels between aviators and ground forces; yet technologically, these were years of steady progress.

The military contributed to the growth of aviation in the United States through some of the exploits of their pilots. Through the 1920s, Army, Navy, and Marine Corps pilots routinely participated in aviation races, and the data collected during these races were used to enhance aircraft and engine design. Military aviators also participated in various record-breaking ventures, such as the first trans-Atlantic flight by Navy aviators in 1919, and the first successful flight around the world by Army aviators in 1924.

Other efforts to assist aviation were more direct. Beginning in World War I, the Navy used a wind tunnel at the Washington Navy Yard to perform experiments on new aircraft designs. In 1917, the Navy established an aviation facility at the Anacostia Naval Air Station, and after the war, it was used to make short test flights. The Philadelphia Aircraft Factory was constructed by the Navy during World War I to build aircraft in large quantities. After the war, the Navy used this factory to build prototypes of new aircraft.[49]

In conjunction with inventor Carl Norden, workers at the Dahlgren Naval Weapons Center developed a bomb-sight that allowed for somewhat accurate high-level bombing. It featured a gyroscope that kept the bomb sight stable, even if the airplane rocked. It also had a mechanism that allowed the bombardier to enter information about the altitude, speed, or drift of the airplane, and signaled the optimum time to drop the bombs. The sight was so effective that the Army Air Corps adopted it and it became the standard bomb-sight for the air campaigns of World War II.[50]

Even with the continued progress of military aviation, significant shortcomings remained during the 1930s. These deficiencies were dramatically demonstrated in 1934, when President Franklin Roosevelt canceled civilian airmail contracts and the Air Corps agreed to deliver the mail. Air Corps pilots lacked the training and equipment to navigate cross-country. Ten pilots died in a series of accidents. Following this operation, the Air Corps began to improve its navigation and training equipment. It began to acquire radios and radio navigation equipment comparable to civilian airlines. It also adopted the Link Trainer, a cockpit simulator. The interior resembled an aircraft on instruments, so a student pilot could practice instrument flying without leaving the ground.[51]

Also during the mid-1930s, the Air Corps began to receive improved new aircraft. While it was struggling with mail delivery operations in 1934, the Air Corps received its twin B-10 bombers. The new airplane carried a crew of four, with three machine guns. It was a significant improvement over its predecessors, but still was not capable of fulfilling aviators' visions of a bomber that could reach deep into enemy territory. In 1935, Boeing Corporation provided the answer with a four-engine bomber that carried five tons of bombs and was protected by five machine guns. Boeing called its creation the "Flying Fortress," and it was redesignated the B-17 by the Army. It became the workhorse of the air campaigns of World War II.[52]

Unfortunately, the impressive speed and firepower of the new generation of bombers caused Air Corps leaders to place less emphasis on the development of pursuit planes for protection. Prior to the appearance of the B-10 and B-17, Air Corps doctrine called for fighters to accompany bombers. Yet these new bombers seemed impervious to pursuit planes. Even Lieutenant Colonel (later General of the Air Force) Henry H. Arnold expressed the opinion that it was "extremely doubtful if single-engine pursuit planes ... can prevent a formation of modern bombardment planes from reaching their objective or destroy the planes either en route to or returning from their objective." The Air Corps did develop the P-35 and P-36, which were metal planes with enclosed cockpits and retractable landing gear.[53] Long-range fighters, such as the P-51, did not come into the Air Corps inventory until after the Americans suffered heavy losses over Germany during World War II.

During the years following World War I, the Navy began to integrate aviation into its operations. In 1922, the Navy converted a collier into its first carrier, the *Langley*. In 1927, the Navy converted two cruisers into the carriers *Lexington* and *Saratoga*. The first American ship built as a carrier from the keel up was the *Ranger*, commissioned in 1934. The Navy entered World War II with some experience in aviation, although the preponderance of its emphasis had been battleships.

Prior to World War II, military aviation employed various forms of lighter-than-air aviation. The slow speed and relatively long staying power of lighter-than-air craft made them appear well-suited for reconnaissance or patrolling duties, especially over the ocean. In time, the vulnerabilities of lighter-than-air craft caused the services to discontinue their use, except for limited anti-submarine duty by Navy blimps.

Lighter-than-air craft could be divided into three categories: balloons, blimps, and dirigibles. The balloon was the earliest type of military aviation, dating as early as the Civil War. It contained a spherical gas bag, and a basket or gondola, without any power mechanism. Although the armies of World War I had used tethered balloons for observation purposes, they were used only for high-altitude scientific work after the war. Each blimp contained an inflatable gas bag, with a gondola that also housed a power plant with rudders and propellers. Dirigibles had a rigid metal frame, with smaller balloons inside the frame to provide the lift capability. They could carry a crew of up to 75 people and cover vast distances.

For all of their magnificence, dirigibles proved to be extremely vulnerable to weather and other hazards. The earliest versions used inflammable hydrogen gas, which caused the explosion on the Air Corps's airship *Roma*, followed by the better-known disaster on the German passenger dirigible *Hindenberg*. Even airships that used helium could be torn apart in rough weather, as the Navy discovered in losing the airships *Shenandoah*, *Akron*, and *Macon*. The *Akron* disaster cost the Navy 73 lives, including that of Admiral Moffett, chief of the Aeronautics Bureau.

Four military installations had particularly strong associations with lighter-than-air aviation. These were Lakehurst Naval Air Station, New Jersey; Moffett Naval Air Station, California; Langley Field, Virginia; and Scott Field, Illinois. Lakehurst, established in 1921 as a station for airships to

patrol the Atlantic coast, contained an airship hanger that was 1,000 feet long and 196 feet wide. Its excellent facilities made it the designated port for commercial airships, and the famous *Hindenberg* disaster occurred there. Even after the Navy stopped using rigid airships, Lakehurst was a base for blimps on anti-submarine patrols during World War II. Moffett Naval Air Station served a similar function on the West Coast through World War II. Langley Field was used for balloon companies during World War I, and it continued to be used for lighter-than-air craft through the inter-war years. One of the few helium production plants was located at Langley until it was converted to a stable for the Air Corps Tactical School in 1929. Unfortunately, the helium plant came to Langley too late to prevent the explosion on the airship *Roma* that claimed 34 lives. Scott Field was designated a lighter-than-air station in 1922, and soon acquired large airship hangers and a helium plant. It became the Air Corps's primary lighter-than-air station.[54]

By 1940, air power was still a relatively new concept in both land and naval warfare. However, it showed promise of becoming a decisive factor, largely due to the significant improvements in aircraft technology. Airplanes of World War II had the range, payload, and firepower to attack enemy cities, ships, and ground forces. During the years after World War II, military aviation used the foundations laid by the pioneers of air warfare to incorporate even greater advances in technology.

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CHAPTER 6
TRANSPORTATION

The U. S. military has both contributed to and benefitted from the development of America's transportation networks. The military has protected U. S. citizens, and thus has secured transportation systems. Scientific and technical advances by the military have improved land, water, and air transportation systems. In return, America's transportation systems have simplified military operations and have allowed the services to consolidate logistical activities.

Military Contributions to Transportation Development

During the nineteenth century, the Army protected westward transportation routes. Between the Appalachians and the Mississippi River, soldiers constructed posts at key transportation points. Cities such as Detroit, Chicago, Cincinnati, and Ft. Wayne began as forts. The Army also bolstered the expansion of the United States through the construction of military roads. The first roads in this region were built to assist in the resupply of soldiers. After the War of 1812, the War Department began to construct a road network in a systematic fashion. In theory, the Corps of Engineers had responsibility for roads intended for civilian use, and the Quartermaster Department had responsibility for purely military roads. In practice, the distinction became blurred. Regardless of which department had responsibility for road construction, enlisted soldiers performed the actual labor of establishing an early transportation system.[1]

Virtually as soon as the United States completed the Louisiana Purchase, Presidential expeditions were sent to explore and map the new territory. In 1803, Meriwether Lewis and William Clark traveled the Missouri and Columbia Rivers to reach the Pacific Coast. At about the same time, Zebulon Pike explored the Colorado Rockies. In 1819, Stephen Long led a scientific expedition to the Upper Platte region and through the headwaters of the Arkansas River and its tributaries.

The Army was active in exploration and mapping and until the Civil War, exploration was an important Army mission that contributed to U.S. western expansion.

In 1818, the War Department organized the Topographical Bureau, thus beginning the Topographical Engineers. With the General Survey Act of 1824, the Topographical Engineers expanded their functions to include mapping and internal improvements. The "Topogs," as they were called, helped to map the borders with both Canada and Mexico. They produced the first reasonable maps of the American Southwest. During the 1850s, Governor Warren led a series of expeditions through the Dakotas and Nebraska.[2]

West of the Mississippi River, the Army established forts along major trails, beginning with Ft. Atkinson in 1819, near the start of the Oregon Trail. In 1827, the garrison moved to Fort Leavenworth, on the eastern border of Kansas. Other forts along the Oregon Trail followed. Some of the most important posts included Ft. Kearny (acquired in 1846), Ft. Laramie (acquired in 1849), and Ft. Bridger (acquired in 1857). Ft. Riley was constructed in 1853 to protect both the Oregon and Santa Fe Trails.[3]

The U.S. Army Corps of Engineers' participation in transportation improvements began in 1824 with the General Survey Act. In that year, Congress authorized the President to employ Army engineers to "cause the necessary surveys, plans, and estimates, to be made of the routes of such Roads and Canals as he may deem of national importance, in a commercial or military point of view, or necessary for the transportation of the public mail." In response, President James

Monroe appointed a Board of Internal Improvement with two Army officers and one civil engineer. From 1824 to 1838, members of the Corps of Engineers surveyed routes for canals and roads in accordance with this act. They worked under the direction of the Board of Internal Improvements until 1832, after which they worked under the direction of the topographical bureau. Beginning in 1828, the engineers began including railroads within their surveys. By the late 1830s, railroads had reached financial stability and Congress began to criticize government aid to railroads. The Corps' involvement in canals, roads, and railroads was eventually phased out.[4]

During the 1850s, Army topographical engineers were tasked to survey possible routes for a transcontinental railroad. Their efforts determined the routes that became the first four railroad lines after the Civil War. From a scientific viewpoint, the railroad surveys produced invaluable information about the geography of the western mountain regions.[5] The Army located forts near key locations along the railroad; for example, Ft. D. A. Russell (later Francis Warren AFB) was established in 1867 near the regional headquarters of the Union Pacific Railroad in Cheyenne, Wyoming, to protect workers along the railroad.

The General Survey Act of 1824 did not include surveys of navigable rivers and harbors, which required Congressional approval. Nonetheless, the Corps of Engineers became interested in rivers and harbors about that time. Congress made its first appropriation for a navigation study of the lower Ohio and Mississippi rivers in 1820, followed in 1823 with funds for a survey of the Great Lakes port at Erie, Pennsylvania. In 1824, Congress made its first appropriation for actual improvements of the Ohio and Mississippi rivers, to remove sand bars and fallen trees. The Corps of Engineers acquired its first "snag boat," designed to remove log obstructions, in 1828. Thereafter, the Corps of Engineers' role in river navigation continued to expand, and inland navigation has remained a major responsibility of the Corps to the present time.[6]

The nineteenth-century Navy made similar contributions to trans-oceanic commerce. The Navy protected U. S. merchant ships from pirates in the Mediterranean and Caribbean. Naval stations at Pensacola and Key West were established, partly, to provide a base of operations against Caribbean pirates. The Navy stationed a squadron to protect American commerce as it expanded into the Pacific. Navy expeditions played a key role in opening Japan and Korea to American mercantile interests.

One of the Navy's most useful contributions to nautical transportation was the development of a set of charts by the Naval Observatory in Washington, D.C. The Observatory began as a map depot in 1833. After its second superintendent, Charles Wilkes, mounted a telescope to conduct astronomical observations, the site became a respected astronomical observatory. Matthew Fontaine Maury, its superintendent from 1842 to 1861, displayed more interest in practical navigation than astronomy. Maury used the log books in the map depot to study ocean currents and to produce charts of the movements of wind and water. Within five years, his efforts produced a "Fair Way to Rio," which designated the best places to cross the equator. The first ship to use his charts saved 35 days off the round trip; thereafter, they became a popular item among Navy and merchant ships. The observatory distributed its charts free to merchant captains who provided the observatory with abstracts of their own observations. During Maury's tenure, the Observatory mapped the currents of all major oceans.[7]

The Navy's Hydrographic Office continued to perform similar functions through the first third of the twentieth century. It had a statutory responsibility to perform functions today performed by the National Oceanic and Atmospheric Administration (NOAA), including mapping ocean currents, publishing notices to mariners, and describing navigational aids. The Navy published nautical almanacs for celestial navigation, and during the twentieth century, broadcast time signals to assist navigators. Part of its activities during the 1930s included measuring ocean

currents by dropping bottles into the water. Each bottle contained a paper with instructions in several languages directing the finder to mail the paper to the Navy.[8]

The Navy's own technological development also contributed to improvements in the American merchant marine. In 1900, the Navy constructed a model ship basin at its Washington Navy Yard to test new hull designs. As the facility was available, the Navy also allowed commercial ship builders to test their models at the basin. When the Navy converted from coal to oil, it experimented with the most efficient methods of burning oil, and then offered courses to merchant seamen on using fuel oil. Its development of ships' power plants also helped improve merchant ships.[9]

Commercial air transportation also benefitted from military experiments in aviation. Army Air Corps, Navy, and Marine Corps pilots flew races and demonstration flights that attracted attention to aviation. Navy aviators made the first trans-Atlantic flight in several hops. Army pilots made the first round-the-world flight, and the first non-stop flight from New York to San Diego.

Other contributions were important to aerial navigation and flying in bad weather. The Air Corps began experimenting with radio aids to navigation as early as 1924. In 1927, two Air Corps pilots flew from California to Hawaii, a far more difficult navigating task than Lindbergh's flight to Europe because the slightest error could have caused the plane to miss the islands. This flight demonstrated the value of radio aids to navigation. Military pilots had recognized that a pilot could become disoriented when he lacked visual references, such as in bad weather. They also developed an instrument that used a gyroscope to indicate if an airplane was in a turn, enabling pilots to fly on instruments.[10]

Despite its contributions to aviation, the Air Corps fell behind commercial aviation in the use of flight instruments. In 1934, the deficiencies of the Army Air Corps became apparent when it agreed to accept responsibility for delivering airmail. Previously, commercial airlines had carried the mail, but President Franklin D. Roosevelt canceled the contracts in a dispute over charges of collusion among the airlines. Air Corps pilots discovered they lacked experience in instrument flying and radio navigation, resulting in a series of fatal accidents that caused Roosevelt to resume civilian contracts for airmail. Subsequently, the Air Corps improved its training program, and adopted the "Link Trainer," a cockpit simulator. The simulator provided a trainee with the effects of instrument flight without leaving the ground.[11]

Benefits of Transportation Systems to the Military

As the military services increased in complexity during the nineteenth and twentieth centuries, the importance of an efficient transportation system increased accordingly. Both in peacetime and time of conflict, the military depended on the ability to move personnel and supplies. Transportation requirements applied not only to the supply lines that followed operating forces, but to the entire network of installations, industries, and operating forces.

Experience during the War of 1812 convinced the government of the importance of roads and canals to national defense. In fact, military usefulness was one of the factors employed to justify the General Survey Act of 1824 and other Congressionally-authorized aids to transportation during the 1820s. The Seminole Wars further confirmed the importance of adequate transportation to armies in the field. Because Florida was relatively isolated and undeveloped, the need to move supplies to soldiers in the field required constant effort by the commander. The Army relied heavily on water transportation, including shallow-draft boats and Army-owned steamboats.[12]

For the most part, the antebellum Army relied on contracted wagons to resupply the western military posts. After 1848, the Army also began to charter ships to move men and supplies to California. In 1855, the Quartermaster Department opened a standing contract with the firm of Russell, Majors, and Waddell, thereby increasing that firm's importance to the growth of the western states. Despite accusations of corruption and favoritism, the contract system proved more economical than government-owned transportation systems. Congress did not allow the Army to enlist teamsters, and soldiers were not trained to handle mules.[13]

The Civil War proved to be the greatest logistical challenge that the Army had faced up to that time. The Union Army took advantage of the established transportation systems, of roads, railroads, and riverboats, east of the Mississippi, to support their troops. Although the Union Army readily recognized the importance of railroads to their efforts, finding the best method of managing the railroads required some initial experimentation. By 1862, the War Department had created an Office of the Director and General Manager of Military Railroads to control railroads that were seized in southern states. The Quartermaster General contracted for rail services in the North. In 1862, the War Department also published regulations to promote efficient use of railroads by forbidding Army officers from detaining scheduled trains. The result was a rail system that functioned reasonably well in support of the northern Army.[14]

River transportation also proved to be vital to the northern efforts, especially in the area between the Appalachians and the Mississippi River. The Tennessee River provided an excellent supply route that could not be destroyed by sabotage. At first, the War Department followed the traditional practice of allowing local quartermaster officers to charter river boats; however, this practice led to high prices and poor use of boats because local officers held boats for long periods of time. By 1862, the Army had established centralized control of river transportation west of the Appalachians and standard contract rates. The result was cheaper and more efficient service.[15]

As the Army returned to the trans-Mississippi west after the Civil War, it again faced the problems of transporting supplies to its widely scattered garrisons. Transportation problems were most serious during the post-war era before railroads reached the region. Wherever possible, the Army used river boats, but few navigable rivers flowed through the region, forcing the Army to rely on contracted wagons to move most freight. Transportation became one of the greatest expenses of maintaining the frontier Army, but as General Sherman noted, the Army had little choice but to pay. "[W]e have no business to put men out here unless we give them food and shelter and all things but sand and water must be hauled from one to four hundred miles." As railroads entered the region, Army freight bills dropped significantly.[16]

The arrival of railroads also allowed the Army to consolidate its western posts. During the 1860s and 1870s, units were scattered into small garrisons for access to potential trouble spots. This arrangement pleased no one. Units were too dispersed for senior officers to control subordinate units. Moreover, the forts were usually considered temporary and consisted of primitive shelters constructed by soldiers. Yet, without an effective method of moving soldiers, no alternative to the system of scattered garrisons was possible. With the arrival of railroads during the 1880s, the Army concentrated units near transportation centers. Posts near railroad lines, such as Ft. Riley, Kansas, or Ft. D. A. Russell, Wyoming, grew into permanent installations, while more isolated posts gradually were closed.[17]

The problems of moving men and supplies in the western regions caused one officer to recommend the establishment of a specialized transport corps in 1884. He argued that:

> The history of all wars, modern and ancient, proves that the army is weakest whose transportation facilities are the most inefficient. A well equipped and

> organized transportation service is a necessary adjunct to every army in the field, and its absence, or even its presence with ignorant or inexperienced officers in charge, has resulted in more disasters and defeats and unsuccessful marches and campaigns than perhaps any other cause.

More than 50 years passed before the Army established a Transportation Corps, but the officer's description of the value of transportation to military operations remained true.[18]

During the Spanish-American War, the Army faced the new challenge of transporting a force over a body of water. The military's lack of experience in this type of operation proved to be a more serious obstacle than the Spanish Army. Even the relatively short move to Cuba required the creation of a port of embarkation, coordinated movements of troops and supplies to the port, and placement of units on ships. The War Department selected Tampa as the port of embarkation, despite limited rail lines. Failure to establish priorities on shipments or to ensure that shipments were labeled properly compounded the transportation problems. Unloaded rail cars filled the sidings from Tampa to Columbia, South Carolina, and important shipments were detained while unnecessary supplies were unloaded.[19]

The acquisition of island territories following the Spanish-American War prompted the Army to develop its own fleet of sea-going ships to support Army forces overseas. This operation became known as the Army Transport Service, and operated under the direction of the Quartermaster General. The ships operated a line from the Pacific Coast to the Philippines, an inter-island service in the Philippines, and other support to overseas stations. They maintained this fleet until World War II, except during World War I when the Navy Department assumed responsibility for water transportation. Today, the Army still maintains a fleet of boats and lighters.[20]

The Spanish-American War provided a modicum of experience in transportation management that was invaluable during World War I. This conflict created greater demands on the nation's transportation systems than had been imagined previously. The nation mobilized more than four million men for the Army, more than half a million for the Navy, and more than 78,000 for the Marine Corps; it shipped about two million of them overseas. Yet the overseas movement of units was only a small part of the transportation problems. Before a serviceman sailed to France, he was transported from his home to a training camp, sometimes to a second camp, and then to the port of embarkation. With soldiers, came requirements for moving unit equipment, including horses and mules. The services also moved supplies, including food and ammunition, to the port and on to France. Cargo within the United States, such as raw materials to defense contractors or building materials to the sites of new cantonments, also taxed the transportation system. Supplies for French and British allies also required transportation, either as raw materials to factories, or as finished products to the Atlantic ports. In addition to these new military requirements, the nation's transportation system needed to accommodate essential civilian needs.

Under these circumstances, the rail system soon became overloaded. As late as December 1916, four months before the United States declared war, shipments to France and Britain congested the port of New York. The U.S. entry into the war only increased transportation gridlock. Railroad officials tried using a committee to establish procedures and priorities for shipments, within the limits of anti-trust laws. Yet their efforts were insufficient. By December 1917, ships were unable to sail from New York because railroad congestion prevented deliveries of cargo and coal. Transportation problems compounded themselves, as rail cars were side-tracked as far as Pittsburgh and Buffalo.[21]

The government tried to alleviate the problem by using a priority system, where the originating agency would "tag" important items for express shipment. The agreement included bureaus from both the War and Navy departments, plus other government agencies. Shortly after the system was instituted, the government discovered that wartime priority systems were likely to be abused. Virtually all government shipments were tagged express, and determination of which shipments truly deserved priority handling was impossible.[22]

At the close of 1917, the government assumed control of the nation's railroads. This step allowed greater coordination between the lines than what was possible under existing anti-trust laws. Equally important, government control allowed a centrally managed priority system. The War Department issued orders that Army consignments could not be shipped to an Atlantic port without a War Department Transportation Order, which could only be obtained from Washington based on the ability of the port to receive the shipment. To coordinate priorities among different agencies, the government created a Director General of Railroads, who coordinated priorities among the War and Navy Departments. The Food Administration, Fuel Administration, Shipping Board, and War Industries Board were created at the same time. Government direction successfully reduced the level of congestion at ports, even as the number of shipments increased.[23]

World War I also required the greatest sea lift of American forces and equipment to that date. The Army Transport Service was designed to move relatively small numbers of soldiers under peacetime conditions, not to handle the requirements of this war. Consequently, the Navy Department assumed responsibility for most of the overseas troop transport. The Navy assembled a collection of American passenger liners, borrowed British ships, confiscated enemy vessels, and assorted other ships to carry about two million service men across the Atlantic. Because of the threat of German submarines, ships were armed and organized into convoys. The convoy system successfully protected all American shipping to France, although a few ships were sunk on the return voyage to the United States. At the end of the war, the Navy transported forces back to the United States using any available ships.[24]

The appearance of motor trucks was another important transportation development of the World War I era. The Army had experimented with motor cars as early as 1899, when it purchased a few electric cars. Traditionalists, though, preferred mule-drawn wagons to move supplies during the first decade of the twentieth century. Although quartermaster officers acknowledged that motorized transportation could move more supplies on hard surface roads, they argued that animals were superior on unpaved roads and trails where the Army operated. As motor vehicles increased in reliability, this resistance gradually diminished. In 1912, the War Department sent an experimental convoy from Washington to Indianapolis, Indiana, by way of Richmond, Virginia, and Nashville, Tennessee. Despite incredibly poor road conditions, the convoy exceeded all expectations for speed and reliability. Even so, Army officers were reluctant to forsake their proven mules and horses. As late as 1915, the Army War College published a study on motor transport during the European war, that argued that animal-drawn transportation would always be necessary because of poor road conditions in a war zone.[25]

Motor transportation proved itself, however, during General Pershing's expedition into Mexico against Pancho Villa. The Americans operated at the end of a long logistical pipeline. To be effective, they needed to move large quantities of supplies quickly. Only trucks had the flexibility and the cargo capacity to support Pershing's swiftly moving force. The punitive expedition began the operation with only two truck companies, but within three months, it had 588 motor trucks, 57 tank trucks, 10 motor machine shop trucks, six wreckers, 75 automobiles, and 61 motor cycles. Newly organized truck companies improvised procedures during their experiences on the abominable Mexican roads, that were used in the future. The way in which

these trucks exceeded all expectations caused the Army to look more favorably upon motor transportation in World War I.[26]

When the United States entered World War I, Army policy dictated that units close to the front used mules and horses to move supplies, while units farther to the rear used motorized transportation. The policy was based on the assumption that roads nearest the front would be in the worst condition, and thus require animal-drawn wagons. The Army continued using horses to move 3 inch and 75 mm artillery, but larger caliber guns were motorized. In practice, the limited availability of trucks required the use of animals even where policy directed using motor vehicles. By the close of the war, the Army had acquired a huge inventory of motor vehicles.[27]

At the close of the war, Army improvements in motor transportation suffered from a general lack of funding. Although the War Department disposed of many trucks, the surplus inventory was large enough to prevent Congress from authorizing new vehicles. The Army continued to use World War I vintage vehicles well into the 1930s, despite improvements in civilian models. The Army finally acquired new trucks in 1933 as a result of the Public Works Administration (P.W.A.) funding to bolster the automobile industry. From that time forward, the Army steadily accumulated new vehicles. By 1939, all branches except infantry and field artillery, were substantially motorized. The cavalry was motorized because it used trucks to move supplies; soldiers still performed their duties on horseback.[28]

In an effort to dramatize the need for improved vehicles and roads, the Army dispatched a convoy from Washington, D.C., to San Francisco in 1919. This convoy brought increased attention to the poor state of the nation's highways, and impressed one observer, Lieutenant Colonel Dwight D. Eisenhower. In 1956, Eisenhower signed into law the National Defense Highway Act, remembering his experiences on this convoy.[29]

During this time, the Army fought to standardize vehicle purchases. The Quartermaster General, supported by the Secretary of the Army, recognized that adequate vehicle maintenance required a system for stocking repair parts. This system only could be effective, however, if the Army kept as few vehicle types as possible in its inventory. The Comptroller General, supported by members of Congress, insisted that trucks be purchased from the lowest bidder, regardless of standardization requirements. This policy was accentuated by the fact that a large percentage of vehicle purchases during the 1930s were justified as relief measures, under the sponsorship of the P.W.A. Thus, the Army could not develop an effective vehicle standardization or repair parts policy until World War II.[30]

Modern military forces required such a wide variety of supplies and equipment that centralized purchasing and distribution became essential. By 1930, the Navy Department used more than 65,000 items of equipment that required transportation to their destinations. During the fiscal year 1930, the Navy spent more than 14 million dollars moving supplies around its ships and installations.[31]

In 1907, the War Department utilized the nation's transportation system, especially the railroads, to establish a system of general depots. The Quartermaster Department operated these general depots to purchase and store supplies for the entire Army. These supplies could be re-distributed to depots within each geographical area.[32] Naval supply centers were the equivalent of the Army depots; they supplied ships and generally were located near existing shore facilities and were served by railroads. Although the services had used centralized purchasing systems on a limited basis during the nineteenth century, the sophisticated logistical systems of the twentieth century depended on an efficient transportation network.

Starting in 1932, the Army Air Corps used its transport aircraft to reduce the cost of its repair parts inventory. In 1932, it developed a provisional 10th Transport Group to provide airlift capability in wartime. The group was headquartered at Wright Field, Ohio, then at Patterson Field, Ohio, with four subordinate squadrons stationed at Air Corps depots. Although the Air Corps occasionally used bombers for moving supplies, it found civilian aircraft to be better suited for this function. At the same time, the Air Corps realized it could not afford to keep expensive repair parts at all stations. Therefore, engines and similarly expensive items were stocked at depots, and shipped by air as necessary. As a result, the Corps saved money by using fast transportation to reduce the need to keep expensive parts at each installation.[33]

When World War II began, adequate transportation again became necessary, both for activities within the United States, and for the widespread deployment of American forces. The Army responded to the growing need for transportation specialists by creating a separate Transportation Corps. The Navy again worked with the merchant marine to move service members and equipment across the ocean; even with the threat of German submarines. In military operations since World War II, an efficient transportation system has been essential to the U.S. position as a global power.

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28. Cary, "Motor Vehicles in the United States Army," 154-165, 233-234.

29. Cary, "Motor Vehicles in the United States Army," 130-132.

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