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Innovation On A Budget The Development Of Military Technology During The Interwar Period, 1919-1939

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INNOVATION ON A BUDGET: THE DEVELOPMENT OF MILITARY TECHNOLOGY DURING THE INTERWAR PERIOD, 1919-1939

by

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ABSTRACT

This thesis investigates the progress of technological development during the interwar period of 1919 to 1939. The interwar period was a time of slashed military budgets and isolationist policies. However, despite political, financial, and organizational handicaps, each branch of the military made significant progress in the development of military technology, and the air corps and navy achieved significantly better results. The reason these two branches were able succeed was through a combination of organizational policy and the development of an overarching goal for their respective branch. Within this thesis, I investigated each of the major military branches during the interwar period, specifically the United States Army, Army Air Corps, and Navy. The air corps is considered a separate branch despite being a segment of the army due to its different strategic goal and its growing independence during the interwar period.

In my research I found that the army made by far the least technological progress, but did make significant strides in terms of the development of individual components for larger projects. For example, the army developed the M1 rifle and state-of-the-art shock absorbers for tanks. The air corps succeeded in transforming from a small army auxiliary made up of wood-and-fabric biplanes into a largely independent branch of the military made up of all-metal monoplane bombers. The navy developed the aircraft carrier and aircraft to accompany the new ships, in addition to making substantial upgrades to existing ships. These upgrades included strengthening ships against torpedo attacks, making engines more efficient, and adding anti-aircraft guns to the ships' arsenals.

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INTRODUCTION

The First and Second World Wars were two of the most monumental events of the twentieth century. Conjointly, they left a lasting impression on the fields of international politics, both popular and academic history, literature, cinema, and popular culture. Almost anyone in America can talk about the major players on each side, the elementary causes of the wars, and most college graduates possess some understanding of how the end of the First World War set the stage for the Second. However, not many could explain what became of the United States' military between the two wars.

World War I saw a number of major achievements in military technology. In this conflict, the armies amassed in Europe witnessed the first major use of machine guns and the introduction of military aircraft. The tank also appeared on the battlefield for the first time. The power, range, and accuracy of artillery increased dramatically. Submarines and aircraft added a third dimension to battles at sea, threatening ships from both below and above the ocean. The first proto-aircraft carriers appeared, formed by cutting the top off an existing ship and replacing it with a platform. Battleships, masters of the high seas, shelled each other from farther distances and with increasingly massive rounds. In a more subtle advance, trucks and other vehicles began to replace the horse as the primary method of transportation of men and material.

Twenty-one years after the 1918 cease-fire, World War II erupted, displaying a massive improvement in all these areas of military technology. Aircraft could fly faster and higher. Tanks

were more mobile, better armored, and at the forefront of the German *blitzkrieg*. Aircraft carriers challenged the battleship for mastery of the sea.

However, between these two conflicts, the United States military faced both internal and external resistance to technological developments, especially within the army. The period between 1918 and 1939 witnessed a return to pre-war organizational policies for the army, the emergence of isolationist politics, and a shrunken budget for all three branches. These events preceded a catastrophic economic crash that shook the foundations of the country. In addition, within the army, there were those who resisted further modernization of wartime tactics and war machines, preferring to continue using the tools that were proven failures even before America's entry into the First World War. However, during the two-decade period between 1919 and 1939, the United States military, especially the air corps and navy, managed to enact a number of substantial technological gains that greatly increased its ability to become the world power it is today.

The purpose of this thesis is to determine how the United States military made technological advances in spite of both internal and external pressures against it, as well as why the air corps and the navy had much greater success than the army. It should be made clear that individual improvements to specific technology are not the focus, although specific examples will be used to highlight progress. Instead, this thesis will examine the individuals and institutions that made this progress possible in the face of the largely anti-military culture present in the 1920s and 1930s. I will attempt to answer the following question: how did the air corps

and navy overcome organizational, budgetary and political issues, and how did they manage to make progress despite these hurdles? In addition, why was the army so much less successful in this respect? Finally, how did the technological developments that originated in this era, specifically in the navy and air corps, permit the United States to successfully engage in World War II?

The historiography of American military history for the first half of the twentieth century concentrates largely on the First and Second World Wars. However, the period between the wars is largely ignored, especially in the area of technological development; specifically in the areas of aircraft, aircraft carriers, tanks, artillery, and firearms. Most of the historiography on this subject either focuses on individual branch achievements, or simply points to the interwar period's isolationist policies and budget issues to explain why certain technologies were not developed. However, I believe that this is an oversimplification; many advances were made despite isolationism and budget shortfalls, especially in the air corps and the navy.

This thesis is unique in that it identifies not only the technological developments that occurred during the interwar period, but also clarifies the difficulties and hurdles inherent in the political situation at the time, and how each military branch dealt with that reality. I explain how the air corps and the navy were able to make significant strides despite political problems by having a unified command structure and a common goal throughout the branch, which is an observation that has yet to be made in the field. In addition, I will show that the army was less successful in overcoming similar hurdles due to the lack of an efficient command structure and

overarching goal. Understanding how the various political, economic, and organizational factors worked together to hinder technological progress within the army is essential to understanding how the navy and air corps averted this same lack of progress. All three branches suffered budget cuts, all three faced isolationist policies, and all three, at least initially, were ruled by an inefficient command structure. Somehow, the air corps and navy successfully overcame these factors, while the army developed to a much lesser extent.

To explain this disparity in achievement, I will primarily be relying on the annual reports published by the heads of each of the military branches. These include but are not limited to the annual reports of the Secretary of War, the Assistant Secretary of War in charge of procurement of materials, the Assistant Secretary of War for the US Air Corps, the US Army Chief of Staff, the Secretary of the US Navy and the Chief of US Naval Aviation. In addition to these reports, I will also use sources published by lower-rank individuals with special knowledge regarding technological and tactical progress. Among these is the naval periodical, the *United States Naval Proceedings*. Published by the navy and in print for nearly a century, it is a forum for naval officers to express their concerns about naval policy and publish their research, observations, and findings. *Proceedings* can, as a whole, be seen as a reflection of naval policy. I will also examine all of the treaties and acts which had a substantial impact on the performance and size of the US military.

There is a fairly stunning lack of historical work done on technological progress itself in the interwar period, considering how much the progress influenced how World War II was

fought. Most of what can be found on the subject must be gleaned from works either covering a much longer period of time, or works written about World War II. The leading work on the subject, *Military Innovation in the Interwar Period*, edited by Williamson Murray and Allan Millet, does focus specifically on this era, but primarily from a British and German perspective, using American innovation only as a comparison.[1]

For general military texts, Russell Weigley's *The American Way of War* and, Benjamin Rhodes's *United States Foreign Policy in the Interwar Period* are essential texts.[2] Weigley discusses the strategies for both the air corps and the navy, and the technological advances associated with those strategies. Rhodes focuses on the diplomatic side of the interwar period, and explains the domestic policies that deeply affected actions of the various military branches. Harold Winton's and David R. Mets's *The Challenge of Change*, Edward Coffman's *The Regulars*, Weigley's *History of the United States Army*, and George Hofmann's *Through Mobility We Conquer* discuss the army's technological developments.[3] Weigley provides a good general overview of the technology of the period, while Winton, Mets, and Hofmann describe the failure of the army to adapt to the new technological realities following World War I. Coffman gives a view of life within the army from the trooper's perspective and the struggles

[1]Williamson Murray and Allan Reed Millett. *Military Innovation in the Interwar Period*. (Cambridge: Cambridge University Press, 1996).
[2] Russell Weigley, *The American Way of War: A History of the United States Military Strategy and Policy*, (Bloomington, IN: Indiana University Press, 1973).; Benjamin Rhodes, *United States Foreign Policy in the Interwar Period, 1918-1941: The Golden Age of American Diplomatic and Military Complacency.* (Westport, Conn: Praeger, 2001).
[3]Harold R. Winton, and David R. Mets. *The Challenge of Change: Military Institutions and New Realities, 1918-1941*, (Lincoln: University of Nebraska, 2000).; Edward M. Coffman, *The Regulars: The American Army, 1898-1941*, (Cambridge, Mass: Belknap Press of Harvard University Press, 2004).; Russell Frank Weigley, *History of the United States Army*, (Bloomington: Indiana University Press, 1984).; George F. Hofmann, *Through Mobility We Conquer: The Mechanization of U.S. Cavalry*, (Lexington, Ky: University Press of Kentucky, 2006).

associated with a peace-time isolationist army. The weakness of these three texts is the lack of discussion about the combination of a funding deficit, poor organization, personal ideologies, and how these factors combined to hinder technological progress.

Robert Love Jr.'s *History of the U.S. Navy* is the preeminent book for naval history, but is fairly general simply because of its scope; it covers the period from 1775 to 1941.[4] There are a number of supplemental sources, most describing the rise of the aircraft carrier, but many of those works focus primarily on World War II and later. The air corps has a plethora of secondary sources, most of them focusing on Billy Mitchell, the air corps deputy director and public face during the 1920s, but also many focusing specifically on the new technological developments. In terms of the historiography, this is a small, but very important, hole to fill: despite the air corps being part of the army, their fates were quite different in this period, and there is no historiographical work on that topic.

Within this thesis, I will be looking at each of the major military branches of the interwar period, specifically the United States Army, Army Air Corps, and Navy. The air corps will be considered a separate branch despite being part of the army due to its different strategic goal and its growing independence during the interwar period. The marines are not included because they were, at the time, not a major branch and did not meaningfully expand until after World War II began.

[4] Robert W. Love, Jr., *History of the U.S. Navy, Volume I, 1775-1941, (*Harrisburg, Stackpole Books, 1992).

This work will be divided into three chapters, each focusing on the army, air corps, and navy. By dividing the chapters by service, rather than chronologically, it avoids the confusion caused by the lack of clear-cut lines in the chronology shared by all three branches. For example, one could consider the years 1935-1939 important for the air corps due to the introduction of the General Headquarters Air Corps; an important step in the air corps' move towards independence from the army. However, these dates would not significantly affect the navy or army. For the sake of clarity, each chapter will begin at the end of the First World War and conclude at the resumption of hostilities in Europe in 1939. Although the United States did not enter World War II until 1941, with the outbreak of the Second World War in Europe, America rapidly began a rearming program across all the branches, ending the political and budgetary characteristics that define the interwar period.

Within this paper, I will show that, despite budget cuts, isolationist government policies, and organizational issues, each branch of the military was able to make technological progress. However, the navy and air corps achieved much more success by overcoming their organizational issues and finding a goal to unite the branch. The army's reversion to an antiquated command system that divided authority rather than concentrating it became the first in a series of blows that ended any hope of the army exiting the interwar period as a world power. When Congress cut both the army's budget and manpower in the early 1920s, this inefficient system was not able to work together to form a unified goal for the army; instead, each department continued to only work their projects, often at the expense of other departments. In addition, several of the department heads did not believe in the mechanization of the army, and

preferred to continue to rely on animal-power. This further limited any potential progress the army could have obtained.

The army's air service found itself in an even worse manpower and budget situation than its parent branch at the end of World War I, and rapidly began to run out of both planes and pilots to fly them. However, through the efforts of one of its senior officers, Billy Mitchell, army pilots proved that air power had a real potential military application. Over the course of the interwar period, the air corps unified its command structure and gained more and more independence from the army, in terms of funding, purpose, and command. Because of this independence, the air corps succeeded in progressing on a number of technological fronts and built itself a niche within the military establishment.

The navy did not find itself mired in budgetary squalor immediately after World War I; in fact, it continued to expand. In addition, shortly after the end of the war, the navy did away with the same inefficient command system that would plague the army for the next two decades. However, in the early 1920s, Congress enacted an international naval treaty that limited the number of ships the navy could build and severely cut its budget. In response, the navy developed a philosophy of quality-over-quantity, and worked to improve its ship's systems as much as possible. In addition, after the air corps showed the potential of air power, the navy developed the aircraft carrier and the aircraft to go with it.

It is clear that air corps and navy succeeded in developing technologically by creating an efficient command structure, and then finding a goal for the entire branch to strive for. The air

corps found a place for itself within the military establishment, and when the navy could not build more ships, they instead made the ships they had better. The army, lacking both of these qualities, did not succeed in developing new technology at any meaningful rate, and ended the interwar period technologically stunted.

In the current era of massive military budgets, growing national debt, and a weariness of war on the part of both soldiers and civilians in America, it is entirely possible that we may be entering another age of isolationism in the United States. At the very least, the military is facing potentially large cuts to their research and development programs. As of April 2011, President Barak Obama plans to reduce military spending by up to $400 billion over the next ten years.[5] Other cuts proposed by members of Congress could reach up to $1 trillion, or twenty percent of the military's total budget.[6] With the potential of deep budget cuts in its future, the military establishment would be wise to look to its past and examine how their predecessors succeeded (and failed) in developing technologically during the interwar period in the face of a smaller budget and a war-weary nation.

[5] Robert Burns, "Gates: Big Budget Cuts Will Diminish US Influence," *ABC NEWS*, May 24, 2011, http://abcnews.go.com/US/wireStory?id=13671508
[6] Robert Dreyfuss, "The Nation: Taking Aim At The Military Budget" *NPR*, March 31, 2011, http://www.npr.org/2011/03/31/135004951/the-nation-taking-aim-at-the-pentagon-budget

HISTORICAL BACKGROUND

Many of the military's successes and failures during the interwar period can be traced to events that occurred between the turn of the century and the beginning of World War I. During this time, the existing branches of the military that are discussed underwent many changes that paved the way for the changes in technology – and implementation – that occurred at a later date. In order to completely understand how the military branches performed in the task of technological development, it is necessary to first briefly look back at the events that each branch underwent preceding the interwar period.

Prior to World War I, both the army and the navy operated under what was known as the bureau system. Under this system, the army and navy split themselves into departments, each in charge of a specific aspect of their branch. The problem with the bureau system was that each individual bureau focused only on the needs, requirements, and goals of its own department, and would ignore the needs and goals of other departments and the branch as a whole. When the military remained small and did not require much in the way of equipment or ordinance, the system did work. However, when the military rapidly expanded in the face of World War I, the bureau system simply could not keep up with demand. Aviation eventually became a department in both the army and the navy, and played a role in how each branch dealt with the inefficiencies of the bureau system.

The army's use of the bureau system greatly affected its readiness for the first world war. Following the Spanish-American War, the army moved from being essentially a frontier police

force to an imperial power, with responsibilities both in the Caribbean and Pacific Rim.[7] Between 1903 and 1916, the army expanded in size through a series of congressional acts, beginning with the Dick Act of 1903 and ending with the National Defense Act of 1916, the last act passed before America's entrance into World War I.[8] However, even these expansions left America unprepared for the war. America entered the war on April 6, 1917 with an army of 127,588 men with an additional 181,620 national guardsmen, for a total of 309,208 men at arms. As a comparison, in the same month the French and Germans lost a combined 290,000 men during the Battle of Aisne.[9]

In 1917, the army underwent a monumental expansion program to meet the manpower requirements of World War I. At this time there were as many as eight different, yet concurrent, systems in place for estimating the requirements of the army, including the Bureau of Ordinance, the Quartermaster Division, the Corps of Engineers, the Signal Corps, the Medical Department, the Construction Division, the Air Service (which, while part of the signal corps, was large enough during the war to have political weight), and the Chemical Warfare Service.[10] In addition, there was no system for determining priority between the bureaus and no system for traffic management of raw materials entering manufacturing plants or finished products

[7] David Johnson "From Frontier Constabulary to Modern Army: The US Army Between the World Wars," in *The Challenge of Change: Military Institutions and New Realities, 1918-1941*, ed. Harold Winton and David Mets (Lincoln, NB: University of Nebraska Press, 2000), 163.
[8] Johnson, "Modern Army", 164.
[9] Johnson, 164.
[10] Benedict Crowell & Rober Forrest Wilson, *Demobilization: Our Industrial & Military Demobilization After the Armistice 1918-1920*, (New Haven, CN: Yale University Press, 1921) 116.

departing to the front. [11] Because of this, in the eighteen months that America participated in World War I, not one American-made gun was made in sufficient quantity to supply the American Expeditionary Force; America's allies in Europe were forced to provide nearly all of the Americans' equipment. America's manufacturing capability was up to the task of producing the needed materials, but because of a lack of coordination between bureaus, some key components went unmanufactured, and others sat completed in warehouses but were not transported to their final destinations.[12] In fact, the number of 1903 Springfield rifles produced before America's entry into the war was *higher* than the number produced after, when the war department took over production regulation.[13]

In response to the problem of inefficiency, the army reorganized itself from a system of departmental leadership to one where the various departments reported directly to the chief of staff, under the leadership of the chief of staff, Gen. Peyton C. March. The chief of staff position, originally created in 1903, had been growing slowly in power since that time and the efficiency crisis in World War I resulted in the army putting each bureau under the chief of staff's direct command. By replacing this bureau system with the chief of staff system, the army was able to have top-down leadership in terms of weapons development, logistics, and general strategy. This is opposed to having multiple bureau chiefs with the same level of authority fighting over resources and pursuing their own interests independent of each other. While the bureaus still existed, their chiefs all reported to the chief of staff and his general staff, who determined an

[11] Peyton March, *Report of the Chief of Staff, US Army, 1919*, (Washington, DC: Government Printing Office, 1919), 15.
[12] Johnson, "Modern Army," 165.
[13] "The American War Department," *The Colonist*, Feb 2, 1918, 4.

overarching strategy for all the bureaus.[14] The efficiency of the army was greatly improved, especially in terms of logistics.

Part of the army's expansion in the two decades prior to World War I included the introduction of military aircraft. The practical application of flight was still less than fifteen years old, and while aeronautical technology improved rapidly in that twenty years, the aircraft were still quite primitive. At the time aircraft entered military service, they were made of wood and canvas, and could not fly very far or fast. At the beginning of the first world war, airplanes were used solely as reconnaissance tools, and air-to-air combat happened almost accidently, beginning with one soldier using a rifle in the back seat of a scout, and ending the war with such ferocity that the term "dog fighting" was used to describe it.[15]

The air corps as an independent branch did not exist in 1918. Instead, all army aircraft were part of the army air service, which in turn was part of the army signal corps.[16] The signal corps was the army department tasked with establishing communications between units, as well as reconnaissance and was not often directly involved with combat. Although aircraft at this time were still primitive and were used mostly for reconnaissance, with some limited ability to fight other aircraft or bomb ground targets, some within the air serive believed it had a much greater potential.[17]

[14] "Baker Divides General Staff into Five Bureaus," *New York Times*, Feb. 11, 1918, 1.
[15] "American Aviators in a Battle Royal," *New York Times*, July 3, 1918, 1.
[16] Bernard C. Nalty, *Winged Shield, Winged Sword: A History of the United States Air Force, Volume I, 1907*-1950 (Washington, DC: US Government Printing Office, 1997), 39.
[17] Nalty, *Winged Shield*, 38-40.

The United States Navy underwent an expansion very much like the army during the two decades before to World War I. Prior to the Spanish-American War, the navy grew into a two-ocean force connected by the Panama Canal and by the end of that war the American navy was considered among the best in the world. Naval commanders began to envision the day that the U.S. Navy would be on par with the British fleet.[18]

The outbreak of hostilities in Europe provided the justification for further expansion.[19] President Wilson implemented a massive naval expansion program in 1916, and America's involvement in the North Atlantic gave the navy valuable wartime experience.[20] In addition, the navy had long been planning for an offensive war with Japan and had devised a strategy called War Plan ORANGE to deal with that potential conflict. This hypothetical plan was constantly updated as new information and technology became available.[21] The navy was, however, limited by the same type of antiquated command system that hindered the army's efficiency before and during World War I. During the war, this system caused a number of readiness and supply problems, greatly affecting the navy's performance in the North Atlantic. At the end of the war, the navy's commanders realized that they had a problem, and set out to fix it.[22]

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[18] "Plans to Make US First Naval Power: Secretary Meyer Reveals Programme for Building Greatest Battleships World Has Seen," *New York Times*, Feb. 27, 1910, 1.
[19] The Great White Fleet was a 16 battleship fleet that circumnavigated the globe from 1907-1909 and was designed to highlight America's new naval power.
[20] "36,000-ton Ships Navy's 1916 Plan" New York Times, Nov. 19, 1915.
[21] Russell Weigley, *The American Way of War: A History of the United States Military Strategy and Policy*, (Bloomington, IN: Indiana University Press, 1973), 245.
[22] Tracy Kittredge, *Naval Lessons of the Great War: A Review of the Senate Naval Investigation of the Critisisms by Admiral Sims of the Policies and Methods of Josephus Daniels*, (Garden City, NY: Doubleday, Pagel, and Co, 1921), 451.

At the end of this period, the army overcame its inefficient command structure and replaced it with a much more efficient system headed by the army chief of staff. The air service still remained a part of the signal corps, and its full potential had not yet been realized. The navy, in terms of numbers, was one of the most powerful navies in the world, but remained under the control of the same bureau-style command structure the army had cast off. In the next three chapters, however, the navy's numbers will be cut, but its efficiency and power will improve. The air service will grow into a powerful and largely independent arm of the military. And the army will fall and fail to develop key pieces of new technology.

ARMY: BUDGETS AND BICKERING

Of the three branches of the military, the army was the least successful at the goal of developing necessary military technology during the interwar period. The reason for this was three-fold. First, the organizational structure of the army was inefficient, plagued with overlapping goals, red tape, bickering, and a lack of a unified command structure. This problem was greatly exacerbated by the funding problems that formed in the wake of World War I and the rise of isolationist politics designed to keep America out of another European war. Of the three branches, the army was the hardest hit by budget cuts due to its perception by Congress and the general public as a solely "offensive" organization with no place in peacetime. The sparse funds given to the already inefficient system created a perfect storm that would follow the army well into the Second World War. This chapter will show that a combination of political, budgetary, and organizational factors greatly hindered the army's ability to develop new technology to keep pace with the rest of the world, and the technology it did develop was not manufactured in sufficient numbers to allow it to be used effectively.

When Gen. March took over as chief of staff in 1918, he recognized the problems inherent to an independent bureau system and set out to correct them. The Overman Act of May, 1918 gave him the authority to make sweeping changes to the army's structure and bureaucracy for the duration of the war.[23] His first step was reorganizing the goals of the existing bureaus to eliminate any redundancy between them. Second, he created new bureaus to manage any duties that the existing departments were not equipped or designed to handle. Finally, March

[23] Johnson, "Modern Army," 166.

reorganized and expanded the army general staff to act as a manager for the bureaus in order to direct their strategy as a cohesive unit.[24] This reorganization, in the form of the Division of Purchase, Storage, and Traffic, proved to be very effective and greatly increased the efficiency of the army during World War I by putting the formation of army policy in the hands of one man, the chief of staff, rather than having the bureau chiefs operate independently and without any central plan or guidance.[25] Because the chief of staff and his general staff had complete control over the bureaus, they were able to rid themselves of the red tape, redundancy, and logistical inefficiency that had plagued the previous system. For example, after Gen. March initiated his reforms, the amount of supplies shipped to Europe in naval convoys increased by 100,000 tons a month, production of Gillette razors increased seven-fold, and rifle manufacture reached over 30,000 per week.[26]

LESSONS LEARNED, LESSONS FORGOTTEN

The army learned many lessons from World War I. First, the necessity of general staff control was made abundantly clear. The various bureaus needed a controlling force to focus their efforts. Second, the advantages of having a stockpile of both clothing and equipment to supply the army until the economy shifted to a war footing became evident. Third, the country needed a larger standing army, especially with experienced officers. New troops and officers took too long to train and more importantly, even longer to gain experience. March was an advocate of

[24] March, *Annual Report*, 17.
[25] Crowell, *Demobilization*, 116.
[26] "Caldwell Predicts Big Ship Increase," *The New York Times* June 2, 1918, 7.; "Sevenfold Increase in Gillette Production in 10 Months" *Spokane Daily Chronicle*, Dec. 17, 1918, 11; "Rifles Enough For Army," *The Reader Eagle*, June 7, 1918, 3.

universal conscription, believing that every man of age and ability should serve a term in the army. In March's opinion, the size of the peace-time army would not differ greatly from a wartime army. Fourth, the army would benefit from the organization of special services such as the Tank Corps and Air Service, whose duties could not be duplicated by regular troops. Finally, World War I crystallized the necessity of large-scale tactical training using a combination of infantry, artillery, armored, and air units. This is related to the need for experience; the army needed to be prepared to go to war at any time and could not rely on gaining experience under fire alone.[27] Unfortunately, most of these lessons would be forgotten early in the 1920s.

In 1921, the army underwent a major reorganization under the guidelines of the National Defense Act of 1920. This act was one of many isolationist policies made in the wake of World War I with a desire to "return to normalcy" and to stay out of European affairs. [28] The army's size was limited to a peace-time maximum of 200,000 men (and would remain below 125,000 after 1922), the tank corps was abolished and tanks (and their crews) relegated to the infantry department. The army's budget was set at $396,000,000, a billion dollars below its wartime budget, and, after adjusting for inflation, only $100,000,000 higher than its 1914 budget.[29] This was in spite of a larger (by 40,000 men) standing army compared to 1914, and the new requirements of armored and aerial warfare.[30] In addition, the role of the chief of staff was

[27] March, *Annual Report*, 241-245.
[28] Raymond Clapper, "Map Out Course for Return to Normalcy" *Washington Reporter*, Jul 27, 1921, 1.; Norman Mackenzie, "Abandonment by U.S. of Isolationist Policies Predicted at Sydney," *The Leader Post*, Sep 19, 1938, 5.
[29] "National Defense," *Reading Eagle,* Dec. 3, 1929, 14.; "Congress Faced With Budget Half Billion Below First Estimate," *Herald-Journal*, Dec. 6, 1921, 4.
[30] "National Defense," *Reading Eagle,* Dec. 3, 1929, 14.

marginalized as the bureau directors once again took control of army policy.[31] March's proposed 500,000-man army was rejected by Congress, both due to unpopularity of the plan among civilians and because of his political enemies on Capitol Hill. March had been blunt with Congress during the war regarding the need of an increased military presence at all times; the unpopularity of this statement allowed his political enemies to gain traction in their fight against him. He was accused of wanting to maintain a high troop count only because his fellow officers wanted to maintain their wartime brevet (temporary) ranks. The final nail in the coffin was when Representative John Miller of Washington asked what enemies the United States had to justify such a large army. March was unable to answer satisfactorily, essentially implying that because the army had the resources to train that many, it would be a shame to not do so.[32] Gen. John Pershing, hero of the American Expeditionary Force in World War I, helped to hammer in that final nail when he stated that the maximum amount of soldiers for a peace-time army should be no more than 300,000.[33] In March's final *Annual Report*, he wrote that should the army drop below 200,000 men, it would simply not be able to perform all the tasks relegated to it, and listed the non-combative requirements of each department; of the 200,000 allotted men, 150,000 were largely non-combat positions. Therefore, a 200,000-man army would only have 50,000 combat troops.[34] March retired in 1921; he was succeeded by the same Gen. Pershing who had denounced him.

[31] George F. Hofmann, *Through Mobility We Conquer: The Mechanization of US Cavalry* (Lexington: University Press of Kentucky, 2006), 87-88.
[32] Johnson, "Modern Army", 169.
[33] Ibid, 169.
[34] March *Report of the Chief of Staff, US Army, 1921*, (Washington, DC: Government Printing Office, 1921), 28.

The return to the bureau system was for reasons both fiscal and ideological. The US government had just spent trillions of dollars on the war effort. In addition to this spending, the government was still locked into billions of dollars of wartime contracts. If these contracts had been immediately cancelled, it would have meant a complete collapse of an economy still entirely on a war footing. Therefore, money had to be saved somewhere. Research and development programs were slashed, as was the size of the armed forces. An army of over 2,000,000 soldiers in 1918 had been cut to 280,000 by 1920 and to 125,000 by 1922.[35] Ideologically, the bureau system was seen as more democratic, "American" and capitalist. The army was to be run like a corporation, with each bureau chief acting as a member of a board of directors for the army.[36] This reaction makes sense if the Communist Revolution in Russia and the resulting Red Scare in the United States is considered.

The marginalization of the position of chief of staff and the return of the bureau heads to power essentially returned the army's command structure to the *status quo ante.* Although the chief of staff position still existed and his general staff still advised the various bureaus, they no longer had direct control, allowing the bureau commanders to regain their control over their departments. In addition, the board of directors mentality never materialized and the bureau chiefs concentrated only on their respective departments. This left the army with the same command issues it had experienced before and during the war, with the additional problem of implementing a program of mechanization and modernization.

[35] John Weaks *Report of the Secretary of War to the President, 1922* (Washington DC: Government Printing Office, 1922) 12.
[36] Weaks, *Secretary of War, 1922*, 14-15.

The invention of the tank and the use of mechanized transportation had greatly changed how battles were fought by increasing the speed of armed conflicts at both tactical and strategic levels; each bureau would have to find a way to approach this new reality. Unfortunately, each bureau only concentrated on its own specific area and gave little thought to a branch-wide strategy; the infantry concentrated on the infantry, cavalry on cavalry, and artillery on artillery, with very little thought for the integration of tactics. Under a strong chief of staff, the army may have been able to focus on these issues as a cohesive unit as they had done in the latter stages of World War I, rather than focusing on them individually. Even worse, the army had started the war with eight different bureaus. After the National Defense Act, it had seventeen, adding to the inefficiency of the system. In addition, Congress was not willing to provide enough funding to fill the 200,000 soldier cap set by the National Defense Act of 1920; funding was also not appropriated for research and development purposes.[37]

ANIMALS OVER ENGINES, TROOPS OVER TANKS

Another problem was that, in many cases, the heads of the bureaus were unwilling to admit that mechanization was necessary at all and remained proponents of an army powered primarily by animals, not engines. This was especially true for the leaders of the cavalry and artillery departments. The cavalry was struggling to justify its existence after World War I proved the obsolescence of horses on the modern battlefield.[38] Machine guns and vastly improved artillery had made the classic cavalry charge suicidal, which left horse cavalry without

[37] Johnson, "Modern Army", 170-171.
[38] John Christmas, "The Mechanization of the Armies," *The Military Engineer,* Vol. XXI, No.199, (Washington, DC: The Mills Building, 1929), 453.

a role on the modern battlefield. The artillery continued working on firing farther, faster, more accurately, and with more damage, but was constrained by a lack of mechanization, making it harder to move larger guns and shells. In addition, artillery had suffered a "period of diminishing returns" in World War I. This means that, at a certain point, the amount of *effective* damage done per shell fired started to go down, and therefore the monetary cost of a bombardment went up exponentially.[39] By 1922, all research into mechanized artillery had been halted and all motorized artillery units had been deactivated.[40]

The Infantry was still considered the most important section of the army and did little to further develop the tank. The Field Service Regulations of 1923 stated "the special mission of all other arms are derived from their powers to contribute to the execution of the infantry mission" and that "infantry is the essential arm of close combat."[41] Both the cavalry and the air service were relegated solely for purposes of reconnaissance, and there was no mention of the two working together toward these ends.

Tanks, which had been reassigned to the infantry in 1920, were largely laid by the wayside in the years immediately following their reassignment. Tanks were effectively forced to weigh less than 15 tons due to the Ordinance Department's unwillingness to modify pontoon bridges to carry more weight (the 1917 Mark VIII *Liberty* tanks, for example, weighed in at 37 tons and could not use pontoon bridges).[42] Instead of focusing on quickly developing new, light

[39] Christmas, "Mechanization", 453.
[40] Weaks, *Secretary of War, 1922,* 302.
[41] Hofmann, *Through Mobility*, 95-96.
[42] Johnson, "Modern Army," 189.

tanks, the army focused more on building armored cars for Mexican border patrol, which were much cheaper and easier to design and construct.[43] The cars were only "armored" in the most liberal sense of the word. The Pontiac T1 and Cadillac T2, first built in 1928, were nothing more than standard civilian vehicles stripped down to base components, with very light armor added and a machine gun attached.[44] These armored cars could not replace the need for tanks in warfare, due to their inadequate armor and armament.

Tank design theory in the 1920s was split between two different approaches; a "light" tank (or armored car) designed to cover and accompany an infantry charge and a "leading" heavy tank designed to spearhead a large assault. These were two very different roles and would have been performed best by two separate vehicles designed exclusively to perform them. The army's Caliber Board, however, elected to design a medium tank able to use existing pontoon bridges rather than design a heavy spearheading tank or a light infantry-support tank. The first medium tank, the Medium A, was a vehicle that incorporated many design features that would continue in American tanks for the next three decades. These developments included the twin-turret arrangement, which placed a small machine-gun turret above the main gun turret. However, after the Medium A was built, the infantry decided to concentrate instead on light tanks and armored cars, leading to a decline in the 'medium tank' design.[45] The chief of the infantry did not support tank design, believing that the infantryman still held the primary role in ground warfare, and

[43] Hofmann, *Through Mobility*, 101.
[44] R.P. Hunnicitt, *Armored Car: A History of American Wheeled Combat Vehicles* (Novato, CA: Presido Press, 2002), 22.
[45] R.M. Ogorkiewicz, *Armoured Forces: A History of Armoured Forces and Their Vehicles* (New York: Arco Publishing Company, 1960), 190.

actively censored subordinates who supported tank design; these subordinates included both Dwight D. Eisenhower and George Patton, who used tanks to great effect in World War II.[46]

Despite a general reluctance against technological development due to both funding shortages and the entrenchment of pre-world-war ideas and tactics among high-ranking officers, some officers within the army did advocate for mechanization. In 1928, the general staff conducted an extensive study under the command of Col. O.S. Eskridge, a member of the tank section of the infantry department. The test was designed to study the potential of a mechanized force and was essentially a hodgepodge of various trucks, tracked vehicles, artillery, and the few modern tanks the army possessed. The test, summarized by Capt. John Christmas of the automotive section of the Ordnance department, succeeded on many levels and highlighted where improvements were needed. The hodgepodge of vehicles caused some problems, with the mechanized column being forced to slow or stop to allow slower or broken vehicles to catch up. However, the column still made a 75-mile "daily march," meaning the mechanized column, despite delays, was able to move about 75 miles a day, which is between three and five times faster than a non-mechanized column. Christmas took several lessons from this test: that vehicle uniformity was essential to keep columns moving efficiently, that aviation would be needed to support an armored column due to the column's vulnerability from air attacks, and that a mechanized force needed specially trained men to do the job properly.[47] In addition, Christmas proposed several tactical and strategic theories based on this test, many of which were very similar to what would become the *Blitzkrieg*; using tanks to punch a hole through the enemy line,

[46] Johnson, "Modern Army," 189.
[47] Christmas, "Mechanization" 452.

and bringing up infantry both in armored troop carriers and on foot to hold the position.[48] Christmas concluded that the advantages of a mechanized force greatly outweighed the disadvantages (high cost and terrain limitations).[49]

Despite these recommendations for and the benefits of a mechanized force, such a force never developed outside the experimental regiment. Rather than develop a technologically superior army, with an emphasis on tanks, the army elected to focus on the development of armored cars. These armored cars were cheaper and faster than modern tanks, but had much less armor and firepower. They would have been used primarily for defense along the Mexican border; however, they were never deployed in large numbers. Interdepartmental bickering between the infantry, cavalry, and ordinance departments hindered the armored car's development up into the 1940s and the Second World War.[50]

The Christie convertible tanks were a prime example of the effects of the lack of cooperation between departments.[51] The 1928 Christie was a revolutionary design for its time, able to drive at speeds up to 70 mph on wheels and 42.5 mph on tracks, which was twice as fast as the model T1 that the army was using as its standard armored car. The infantry purchased a total of eight of the tracked version and the cavalry bought four of the wheeled "combat car"

[48] Christmas, "Mechanization", 454-455.
[49] Ibid, 456.
[50] R.P. Hunnicitt, *Armored Car: A History of American Wheeled Combat Vehicles* (Novato, CA: Presido Press, 2002), 22.
[51] "Convertible" in this case means the ability to operate on truck wheels or tank treads

version.[52] These amounts did not come close to providing an adequate number of armored vehicles for the army.

The bickering began in 1933 when the Ordinance Department developed an updated version of the Christie. It was 4 tons heavier and much more powerful. However, it had some problems because of the Ordinance Department's insistence that it be able to run with both wheels and tracks, causing steering complications. In hindsight, the wheeled version should have been abandoned due to the complication of creating a drive system capable of handling both wheels or tracks and the limited utility of the wheeled version. However, the infantry demanded a tracked version and the cavalry the faster wheeled version. Rather than either fixing the problems or proceeding with only the tracked version, the project was abandoned completely in the United States (although the Soviet Union purchased the design and made good use of it.)[53]

President Herbert Hoover's military policies during his administration (1929-1933) further hindered the mechanization of the army and the development of tanks. Hoover wanted to adopt a policy of 'hemispheric defense,' which ran in line with the current isolationist tendencies. He planned for a quick expansion of the military during war time, but during peacetime to maintain only enough military power to defend the Western Hemisphere. He advocated for the mechanization of the peacetime army, but he also advocated a 40 percent expansion of the air corps and took the money to fund this expansion from the infantry and artillery departments. The air corps received $3 million for new aircraft. The rest of the army

[52] Ogorkiewicz, *Armoured Forces*, 191-192.
[53] Ibid, 192.

could only allocate $626,000 to new construction, and split *that* money with maintenance costs for the national guard and an increased troop ration.[54] The resulting budget crisis for the rest of the army was so critical that it lost the ability to adequately defend the Western Hemisphere, let alone project force anywhere else. In addition, the higher air corps funding further strained the already tense relationships between departments.[55]

Chief of staff Charles Summerall wrote in 1929 that the army was unprepared for a war in the following areas: mobilization, aircraft, harbor defense, anti-aircraft, selective service, new weaponry (both in R&D and production), rearmament, and intelligence on the activities of foreign armies.[56] In his final report as chief of staff made the following year, Summerall unequivocally denounced the bureau system, stating that "the defect of divided authority, which brought about great confusion during [World War 1], had been completely eliminated under a system of General Staff control, when unity of authority and responsibility under the chief of staff was fully achieved."[57]

COMPONENTS ARE DEVELOPED AS TRAINING DRAGS

In 1930, Gen. Douglas MacArthur took over the position of chief of staff. At the time, the army consisted of only 12,000 officers and 118,750 enlisted men, nearly 70,000 fewer than the minimum stated by Gen. March nine years before. Like March, MacArthur restated that because

[54] "Cruiser Bill Fight Nears the End," *The Troy Tribune*, Feb. 8, 1929, 2.
[55] Hofmann, *Through Mobility*, 122.
[56] Gen. Charles Summerall, "Chief of Staff Annual Report" *Report of the Secretary of War to the President, 1929* (Washington DC: Government Printing Office 1929) 101.
[57] Gen. Charles Summerall, "Chief of Staff Annual Report" *Report of the Secretary of War to the President, 1930* (Washington DC: Government Printing Office 1930) 108.

certain administrative offices *must* be filled, the majority of the manpower shortages were felt by the fighting elements, hindering both the efficiency of these units and their ability to defend the nation. He wrote that, even by cutting "mobilization and administrative nuclei to the bone and (reducing) foreign and coast defense garrisons to dangerously low figures," the bare minimum manpower for the army must be 14,000 officers and 165,000 enlisted.[58]

Unlike March and his immediate predecessor, Summerall, MacArthur supported the bureau system, especially in the areas of research and development of mechanization and motorization. He did advocate a "General Council" of bureau chiefs to help curtail overlap, but this seems simply a rebranding of the ineffective board-of-directors organization of a decade before.[59] This raises the possibility that MacArthur either received his appointment to the chief of staff position because of his political beliefs, or that he was pressured to support the system in order not to make waves.

MacArthur did write in his chief of staff reports that the army had made steady progress on a variety of technological fronts. However, the development and procurement of these technologies had been severely handicapped by the lack of funding available to the army. In the early 1930s, the army, aside from a small number of new tanks and armored cars, still largely used equipment left over from World War I; much of this equipment was approaching

[58] Douglas MacArthur, *Report of the Chief of Staff, US Army, 1934* (Washington, DC: United States Government Printing Office, 1934), 22.
[59] Gen. Douglas MacArthur, "Chief of Staff Annual Report" *Report of the Secretary of War to the President, 1931* (Washington DC: Government Printing Office 1931) 42.

"mechanical exhaustion."[60] Other World War I surplus equipment, while still usable, was obsolete to the point that if an emergency arose, it could not be used effectively against an enemy armed with modern equipment.[61]

At the time that Gen. MacArthur took over as chief of staff, the United States had several hundred tanks remaining from World War I, but only twelve tanks that could be considered modern (mostly Medium As and Christies) - only one of which was operational. New tanks were capable of 40 mph on roads and 20 mph off-road (the 1917 Liberty tank, by comparison, reached a top speed of 5mph under ideal conditions). However, it cost all of the army's available funds to procure one working model.[62] All of the new tanks were critically under-armed, having nothing heavier than a .5-inch machine gun or a 1.5-inch cannon, which was not large enough to be effective against other tanks[63] The army's meager efforts to procure more technologically advanced systems ignored the reality of advances being made in other parts of the world. The army did, however, make significant strides in the 1930s in the area of internal mechanics. Among these developments were air-cooled radial engines, better transmissions, improved suspensions and shock absorbers, and more rugged treads. These developments would eventually produce reliable and efficient vehicles and would pay large dividends in World War II. After the interwar period, the army made use of these components to design a number of vehicles, such as

[60] MacArthur 1934, 4.
[61] Ibid, 4.
[62] Ibid, 8.
[63] Ogorkiewicz, *Armoured Forces*, 192.

the Sherman tank, but at this time, these components remained individual systems, not part of a single, usable design.[64]

Artillery was in much the same position as the tank. The army still relied on the World War I gun known as the "French 75mm." This gun was not capable of maximum-range fire without digging a hole to raise the barrel of the cannon to a 45-degree angle. The gun also had a maximum traverse (or swivel) of six degrees, and could not be rapidly transported from one place to another without being damaged by the stress of travel. Newer guns were capable of this rapid movement, a ninety-degree traverse, and were able to fire at a 45-degree angle without digging in. However, like tanks, the technology for artillery had been developed but was not widely distributed due to lack of funding.[65]

Following this trend of creating designs, but not producing them in sufficient numbers, the infantry had developed a new rifle, the M1. This rifle was capable of firing three times as fast as the Springfield 1903 rifle used in World War I, with significantly less fatigue failure. The M1 weighed the same at the 1903 Springfield, which, along with the improved firing rate, made it more favorable to the infantryman tasked with carrying and firing said rifle. At the end of MacArthur's term as chief of staff in 1935, however, the army had only allocated funding to procure eighty M1 rifles, enough to equip only a large platoon or small company.[66]

[64] Ogorkiewicz *Armoured Forces*, 193.
[65] MacArthur 1934, 9.
[66] MacArthur 1934, 9.

MacArthur, in his 1934 chief of staff report, outlined a list of necessary steps to bring the army to war readiness, which he considered essential to defend the country. These steps consisted of:

1. Continuous development of military technology in order to have a qualitative edge over an opponent.
2. Purchase of a sufficient amount of new designs in order to develop new tactical and strategic doctrines to match new developments.
3. Replacement of old technology with new as the old wears out, as opposed to replacing old parts with old surplus.
4. Determination of how many of the new models would be required in a war and the ability to procure them during peacetime.

These steps were not met between MacArthur's report and the beginning of World War II. Because the steps were not met, the army continued to languish in budget deficits and the inability to procure proper modern equipment. As a result, much of the army was forced to train with World War I equipment. Because they were using old technology, the soldiers were constricted to using outdated World War I tactics.[67] Without producing new weapons, mechanized transport, tanks, and field artillery in large amounts, troops were unable to train with the new technology to become familiar with how it worked. Just as importantly, officers were unable to experiment with the new tactics and strategies the new technologies allowed. Experimenting and training with new technology is just as important as designing it.

[67] MacArthur 1934, 10-13.

The New Deal greatly changed the atmosphere of funding in all the military branches. In an effort to create jobs, the federal government, under President Franklin Roosevelt, allocated millions of dollars to each of the military branches for new construction and research. In 1934, the army received a $10,000,000 stipend from the Public Works Administration (PWA) for vehicle construction and an additional $6,000,000 for ammunition. Using this money, the army was able to begin a procurement program, including 150 tanks and combat cars and 3,340 new semi-automatic rifles, as well as smaller numbers of field artillery and anti-aircraft guns. The army was also given permission to expand to 165,000 men. However, outside of the increased number of enlisted men, this was a drop in the bucket in terms of the army's total needs, and MacArthur objected strongly to the allotment of $238,000,000 to the navy. MacArthur objected even more about the air corps, which received $45,000,000 from the PWA independent from the rest of the army. MacArthur's objections went unheeded; however, because the air corps and navy were seen as defensive entities, it was politically easier to grant them money to expand in order to create jobs.[68] Therefore, the army continued to be understaffed, underfunded, and underequipped.

OBSOLETE EQUIPMENT AND OBSOLETE TACTICS

In 1935, Gen. Malin Craig took over as the army chief of staff. At this time the army budget crisis had reached a point so critical that many soldiers were not being equipped with any equipment at all, let alone modern equipment. This was partly due to the expansion of the army to 165,000 men. New soldiers were coming in at a much faster rate than new materials, leading

[68] Douglas MacArthur, *Report of the Chief of Staff, US Army, 1935* (Washington, DC: United States Government Printing Office, 1935), 22

to a major procurement discrepancy.[69] In addition to this problem, Congress cut the army's budget by over $100 million between 1934 and 1935.[70] Seeing that it was impossible within the current financial and political atmosphere to properly equip the army with enough modern equipment, Gen. Craig elected to go the opposite direction and implemented his Protective Mobilization Plan.[71] This plan called upon a 400,000-man force to be made up of both Regulars and National Guard units, which at least came close to Gen. March's 1921 estimate of 500,000 men to maintain national security, and well above his minimum estimate of 200,000. However, most of the 400,000 man force would be National Guard units, which are militia and do not have the same level of training as regular soldiers.

To get the money to raise this size force, Gen. Craig froze all research projects and reduced the amount of army money going to research to .8% of the total army budget, down from approximately 5.6% during the previous decade. This led to soldiers being issued equipment that was obsolete before it was built. New tanks, guns, and rifles never entered production in significant numbers, but the plan at least gave each soldier a rifle.[72] Gen. Craig was also not a major proponent of tank warfare. After observing the Spanish Civil War (1936-1939) and the Sino-Japanese War (officially 1937-1945, but with border skirmishes beginning in 1931), he concluded that tanks would remain, as they had been in World War I, infantry support

[69] Harry Hooding, *Report of the Secretary of War to the President, 1938* (Washington DC: Government Printing Office, 1938) 12.
[70] "U.S. President Asks Congress For More Cash," *Leader-Post*, Jan. 7, 1935, 5.
[71] Johnson, "Modern Army," 183.
[72] Ibid, 183.

weapons.[73] In addition, he believed that the wars proved that defense had regained the ground lost to tanks at the end of World War I, and that a defensive mindset and strong infantry were the keys to winning a war. This defensive, infantry-centric mindset led to the United States falling even further behind other world powers in terms of tank development.[74]

When Gen. George Marshall took over as chief of staff in 1939, he inherited an army in shambles. The regular army contained only 174,000 enlisted men scattered over 130 different bases. The army had no men to commit to a field army should the need arise, with nearly all of these 174,000 men committed to essential non-combat duties, or garrison duty in the Philippines. The available budget for training amounted to less than five percent of the total army budget, which Marshall described as "that of a third-rate power."[75] The army had been restricted to a two-week training cycle every four years, of which only five days contained actual maneuvers due to a lack of motor transport. This was unacceptable to Marshall, and he sought to change the army structure once again.[76]

Even as late as 1939, when World War II had already begun in Europe, Marshall still received resistance from department heads against modernization. Both Gen. Robert Danford and Gen. John Herr, chiefs of the artillery and cavalry respectively, were proponents of animal

[73] Gen. Malin Craig, "Chief of Staff Annual Report," *Report of the Secretary of War to the President, 1937* (Washington DC: Government Printing Office, 1937) 34.
[74] Gen. Malin Craig, "Chief of Staff Annual Report," *Report of the Secretary of War to the President, 1938* (Washington DC: Government Printing Office, 1938) 30.
[75] Gen. George Marshall, *Biennial Report of the Chief of Staff, 1940-1941*, (Washington, DC: US Government Printing Offices, 1943), 2.
[76] Ibid, 2.

power over mechanized power through their removal in 1942.[77] In February 1939, Marshall, as deputy chief of staff, had written to Congress about the most critical aspects of the army's needs: replacing the 36-year-old Springfield rifle design with the M1 as the standard-issue rifle, modern artillery, manufacturing and distribution of anti-air and antitank munitions to army units, manufacturing ammunition reserves, and that Congress deem these matters as necessary for National Defense, rather than further cutting an already shoestring budget.[78] Fortunately for Marshall, after the outbreak of hostilities in Europe, Congress raised the army's budget by just under $200 million, to $513,188,782, independent of air corps allowances.

At the end of the interwar period, the army was in much the same position that it had been in at the beginning. It was under-funded, under-strength, and under-trained. Most of its units were still using outdated equipment from the First World War. Mechanization still needed further development. The size of the army was still tens of thousands of men short of what the chiefs of staff believed to be the minimum troop level to defend the country. The budget, while slightly larger than it had been prior to World War I, was not enough to overcome the bureau system's inefficiency and additional need to develop mechanization and motorization. In addition, the budget problem only got worse during the mid-1930s, just as war began to appear on the horizon. This dire situation severely affected the United States' ability to involve itself in any armed conflict, especially a potential two-front war.

[77] Johnson, "Modern Army,"187-188.
[78] Gen. George Marshall, *Biennial Report of the Chief of Staff, 1940-1941*, (Washington, DC: US Government Printing Offices, 1943), 1-3.

The failures of the army to modernize cannot be laid at the feet of one institution or event. The isolationist and defensive policies adopted in the early 1920s, especially the National Defense Act of 1921, cut both the army's manpower and funding to the bone. In addition, the marginalization of the position of chief of staff and the resurgence of the bureau system hindered a cohesive effort towards modernization. Despite the support of mechanization by each of the chiefs of staff, many of the bureau heads disagreed up until the beginning of World War II, including the heads of both the artillery and cavalry departments as late as 1942. Despite this resistance, in addition to a lack of funding, the army was still able to make progress, designing modern and innovative components for tanks. These tanks, however, were also armed with under-strength and obsolete weaponry. Although the army had designed the M1 rifle, fewer than 5,000 were made, and most of the army still used the 1903 Springfield rifle as a primary weapon. The artillery department still relied on an antiquated design and cancelled its mechanized artillery program completely. In addition, funding problems did not allow the army to produce any new designs in significant numbers. This, coupled with the lack of funding for large-scale training maneuvers, meant the army did not know how to make use of what little new equipment it did have. In all, the interwar period can be considered an utter failure for the army. Fortunately for the United States and its international military standing, other branches of the military did not flounder as severely.

AIR CORPS: FROM FABRIC TO FORTRESSES

The years between 1918 and 1926 were very difficult for the air service. The budget cuts enacted by the National Defense Act of 1920 affected the air service even worse than the rest of the army, and it rapidly found itself running out of both aircraft and men to fly them as the planes crashed or broke down and pilots were killed or left the service. The government cancelled over $100 million worth of production contracts for the air corps as soon as the war ended, and the aircraft industry as a whole shrank to ten percent of its wartime size.[79] The air service was cut to 9,000 men, down from nearly 200,000 officers and enlisted men at the end of World War I, and could not produce any new aircraft. In 1924, the air service only had 800 active aircraft, and many of these were obsolete DH-4s, which the British had begun replacing in 1914 for being slow, underpowered and unreliable.[80]

In 1921, Gen. Pershing became the army chief of staff, and reorganized the air service among the commanders of ground forces, making the chief of the air service a glorified quartermaster with little in the way of actual authority.[81] However, unlike the rest of the army, army aviation succeeded in unifying its command structure and finding a role to fulfill in a peacetime military. This, along with a mutually beneficial relationship with civilian aviation, allowed the air corps to transform over the course of twenty years from a small, obsolete reconnaissance auxiliary to a largely independent force of cutting-edge bombers.

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[79] Alex Roland, *Model Research: The National Advisory Committee for Aeronautics, 1915-1958* (Washington DC: US Government Printing Office, 1985), 51.
[80] "Air Force History Overview" http://www.af.mil/information/heritage/overview.asp, accessed June 1, 2011.
[81] "War Department's Plan for Reserve Army of 2,000,000," *The New York Times,* July 3, 1921, 69.

THE ERA OF BILLY MITCHELL

Despite its troubles in the early 1920s, the air service was not without its proponents. One of the most outspoken proponents of the air service and air power during this period was the deputy director of the air service, Gen. William "Billy" Mitchell. Mitchell had been in the army since 1898 and had made several tours of the Pacific Rim, analyzing the defensibility of America's Pacific holdings and observing the Russo-Japanese War. In 1916, he transferred to the aviation section of the signal corps, which was the forerunner to the air service. In 1917, he was sent to Europe as an aviation observer and spent the course of the World War I observing military aircraft in France.[82]

Mitchell returned from the war with the realization that aircraft could become an essential element to a modern military force. He was determined to form an independent air force in the United States, on par with the army and navy in terms of importance within the military.[83] He saw that the new isolationist policies being enacted by the government would lead to a focus on defensive strategies over offensive, so he steered his tactics in that direction, specifically towards coastal defense.[84] This, incidentally, would lead to thirty years of competition between the navy and the air service over the question of who would be in charge of coastal defense.[85] Mitchell had some success, but his plan for an independent air force hit a solid wall of resistance with both the heads of the army and the navy. Pershing insisted that the air service should remain an

[82] Hurley, Alfred F. *Billy Mitchell: Crusader for AirPower*. (New York: F. Watts, 1964), 12.
[83] Hurley, C*rusader for Air Power*, 43.
[84] Ibid, 43.
[85] Timothy Moy, *War Machines: Transforming Technologies in the U.S. Military, 1920-1940* (College Station, TX: Texas A&M University Press, 2001), 54-55.

army auxiliary, while the navy had had its own air program for years and had no intention of giving it up, as naval aviation needed to focus on different goals.[86]

Because he was unable to gain support for an independent air force in Congress due to opposition from the army and navy, Mitchell turned to the public forum. He actively campaigned against the navy in the press, claiming that the battleship was obsolete and could be easily sunk by aircraft, which cost a fraction of what a battleship cost.[87] In fact, Mitchell believed that the navy was largely obsolete as a whole and that nearly all their missions could be performed and exceeded by aircraft. He estimated that the cost of a naval battle group, consisting of a battleship and its escorts, well exceeded $100,000,000. For this cost, he claimed an air force could build 4,000 aircraft, far more than would be needed to sink that battle group. At the time, the fleet contained 18 battleships, each of which needed its own escorts; consequently, Mitchell estimated that 72,000 aircraft could have been built for the same price.[88] Mitchell argued that an air force of that size would be able to defend the coast and control sea communications by locating and attacking any enemy navy long before their battleship's guns could reach the coast. By early 1921, his public attacks on the navy had gained enough public support for Congress to force the navy to allow a test of Mitchell's theories, especially his claim to be able to sink a battleship with only a small number of aircraft.[89]

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[86] Nalty, *Winged Shield*, 77
[87] William Mitchell, *Winged Defense: The Development & Possibilities of Modern Airpower – Economic and Military* (New York: GP Putnam's Sons, 1925), 110.
[88] Ibid, 110.
[89] "American Aircraft to Test Effects of Bombs On Captured Warships," *Reading Eagle*, June 19, 1921, 10.

On July 21, 1921, Mitchell's aircraft concluded a demonstration of their potential by successfully sinking an old German battleship, the *Ostfriesland*, although they violated many of the test parameters to do it, including altitude limits, bomb size, and attack patterns.[90] The navy protested that because of these violations the test was not conclusive. Nevertheless, the battleship was at the bottom of the harbor, and that was all that mattered in public opinion. Mitchell was openly contemptuous of the navy in his report on the test, mocking the sailors' panicked responses to debris from bomb detonations landing on their ships' decks. Ironically, despite his success in sinking all the targets in dramatic fashion, the test ended up being a set-back for Mitchell's plan for an independent air force, because it solidified the navy against Mitchell personally and induced it to pursue its own aviation techniques.[91]

In 1923, Mitchell continued his campaign to convince the military and government of the need for an independent air force. Using eighteen bombers, he provided a small-scale demonstration showing that an air force, using concentrated bases, could be used to defend any point in America, especially the sparsely populated center.[92] This defense would require a concentration of force that was in conflict with Gen. Pershing's strategy of even distribution of aircraft amongst the army's ground units. It was Mitchell's opinion that small amounts of aircraft stationed with ground forces would not be able to project a unified force against an enemy, diminishing their offensive capabilities and allowing them to be defeated in detail.[93] Toward the

[90] Nalty, *Winged Shield*, 95.
[91] William MacBride, *Technological Change and the United States Navy, 1865-1945* (Baltimore: Johns Hopkins University Press, 2000), 42.
[92] Hurley, *Crusader for Air Power*, 67.
[93] Ibid, 67.

end of 1923, Mitchell departed on a grand Pacific tour to once again inspect the military's positions and relative strength. He concluded that war with Japan was likely and edging toward inevitable. However, he also concluded that the United States was no longer the dominant power in the region, losing that claim to the Japanese. Mitchell spent the next year contributing to the tactical and doctrinal growth of the air service. He wrote a manual for air bombardment and a comprehensive Pacific air strategy to combat the Japanese. These two works were nearly a decade before their time; the technology to put his theories into practice would not be developed until the mid-1930s.[94]

In 1925, a confluence of events occurred that ended Mitchell's career. First, the military and government ignored his plan for the Pacific theater. Second, the government decreed that the army and navy would continue to maintain control over their own aviation and aviation strategy, and that it would not create an overarching Department of Defense to oversee the army, navy and Mitchell's proposed air force. Mitchell was so frustrated by these decisions that when the navy dirigible *Shenandoah* crashed on September 3, 1925, killing 17 men, he lashed out against the government, accusing them of "incompetency, criminal negligence, and almost treasonable administration of National Defense."[95] This gave President Coolidge, who already wanted Mitchell out of the army, the ammunition he needed to court-martial Mitchell.

By this time, Mitchell had made enemies of President Coolidge and Secretary of War Dwight Davis for his criticism of their handling of America's air services. In addition to these

[94] Hurley, *Crusader for Airpower*,104.
[95] Ibid, 110.

power players, Mitchell's embarrassment of the navy and subsequent attempt to annex the navy's air service caused the naval air chief, Adm. William Moffett to remark, "I wish he were in hell."[96] The majority of Congress, the media, and the general populace supported Mitchell (there were actually demonstrations of support for him when a rumor was circulated that he would be hanged for treason); the army was split, but mostly wanted the whole issue to go away. But the Executive Branch hated Mitchell from Coolidge on down.[97] Coolidge took over the investigation personally, and stacked the jury against Mitchell.[98] He was convicted of breaking discipline and sentenced to be suspended from the army for five years. Mitchell resigned from the army on February 1, 1926, effectively ending his time as the driving force behind military aviation in the United States.[99]

THE NACA AND THE FORMATION OF THE AIR CORPS

Although Billy Mitchell was one of the most vocal proponents for the importance of air power, he was not the only individual or organization working toward the technological advancement of the airplane. The National Advisory Committee for Aeronautics (NACA), founded in 1915, was established by the United States government to effectively coordinate aeronautical research. Following the post-World War collapse of the air industry, the NACA dramatically reorganized itself to suit the new budget reality. It adopted four principles to govern

[96] Emile Gouvreau & Lester Cohen, *Billy Mitchell: Founder of Our Air Force and Prophet Without Honor*, (New York: EP Dutton and Co., 1942), 121.
[97] Gouvreau, *Prophet,* 123.
[98] Ibid, 125.
[99] "Mitchell Gets Permission to Quit Army." *Prescott Daily Courier*, January 29, 1926, sec. 1, p. 1. http://news.google.com/newspapers?id=7y8xAAAAIBAJ&sjid=S08DAAAAIBAJ&pg=5366,1211786&dq=william+mitchell+court+martial&hl=en.

its existence: 1, that the military services would be responsible for all training and personnel policies within their branch, as well as the engineering development of aircraft for their branch; 2, that the Post Office would be in charge of its own aviation; 3, that the NACA would retain its duty to advise and organize aviation research; and 4, that an Air Navigation Board would be established within the Department of Commerce. The last principle created an official department to regulate and encourage civilian aviation, controlled military air power at the government level, and provided a joint board for the leaders of various air departments to meet.[100]

Continuing to trim the bureaucratic fat, in 1919, the NACA abolished sixteen of its eighteen existing research subcommittees and replaced them with four new "technical" committees, three of which would account for eighty-eight percent of the reports published by the NACA over the remainder of its existence. [101] During this period, the NACA became less strictly "advisory" and became more involved with the research itself. The research goals of the NACA were fairly conservative in nature; they did not strive for great leaps forward, but rather for gradual progress based on engineering rather than science.[102] This means that building models and physically testing them became more important than theory.

The NACA's process for accepting and researching a problem was fairly straightforward. The appropriate NACA committee would receive a suggestion for research from either NACA staff or an outside source, typically a government agency or the military. All military requests

[100] Roland, *Model Research*, 52-55.
[101] Ibid, 74-75.
[102] Ibid, 96.

were automatically accepted, and all others were examined to see if they added fundamental knowledge to the field of aeronautics. If they were approved, they were given research authorization and forwarded to the NACA research lab in Langley, Virginia. This system allowed for research to be reviewed from the beginning and periodically thereafter and greatly increased research efficiency. One of the most successful developments to come out of the NACA was a new engine cowling for aircraft engines that was developed within months of the initial request. This led to the NACA winning its first Collier Trophy, an annual award for the greatest achievement in aeronautics.[103]

The early 1920s also saw the emergence of metal aircraft and a decline of new wooden designs. Initially, the shift from wood to metal was primarily a marketing decision, not a material one. Metal at the time had no inherent superiority as an aircraft building material. It was much heavier, especially in the wing area. It was more expensive than wood, and wood actually had a stronger tensile strength than metal.[104] However, the public ideology of progress through technology made metal a more popular choice as a building material. Wood was seen as an impermanent, imprecise, and unreliable pre-industrial material, while metal was seen as a permanent, efficient, and fire safe post-industrial material. Despite evidence discounting this perception and the fact that airplane fuel and not the wooden design was the main danger, metal designs rapidly won support from the military and the NACA. This shift from wood designs to metal also denoted a shift in engineering from an art to more of a science. The metal designs

[103] Roland, *Model Research*, 114.
[104] Eric Schatzburg, *Wings of Wood, Wings of Metal: Culture and Technical Choice in American Airplane Materials, 1914-1945* (Princeton: Princeton University Press, 1999), 47.

encouraged research, and metals had more overall potential than wood, despite the fact that wooden designs could outperform metal designs at the time. Metal designs also lent themselves to mass-production techniques, whereas wood designs had to be built largely by hand by skilled workers.[105] In addition, the army feared that wood could not be produced in sufficient quantity during wartime to build the number of planes they would need. Without any real data to support it, they assumed that metal could be produced in sufficient quantity.[106]

Nearly a decade passed before any usable metal prototypes were developed for the air service. Weight, performance, and cost were all significant problems for metal designs, which led the air service to delay producing all-metal aircraft, although they still supported an all-metal ideology. There was some success with metal wing spars due to metal's higher compressive strength, but the air service would not produce any functional all-metal designs until the mid-1930s, made possible by a number of congressional acts designed to strengthened the aeronautics industry.

Between 1923 and 1926 a series of several congressional boards and acts dramatically changed the course of both military and civilian aircraft in the United States. In 1923, in response to Mitchell's bombing tests, the Lassiter Board was convened to review the state of the air service and the civilian air industry. The air industry had lost millions of dollars in construction contracts when World War I ended, and civilian buyers could buy wartime surplus aircraft rather than purchase new planes from manufactures. What the Lassiter Board found was not inspiring.

[105] Baily Wright, *Flight:Construction and Maintenance, a General Survey of Fundamentals of Aviation*, (Chicago, American Technical Society, 1941), 136.
[106] Schatzburg, *Wings of Wood*, 144-145.

The Board reported on personnel shortfalls and aircraft deterioration. In addition, they found that the lack of military contracts was causing a significant hardship for the civilian air industry. In 1924, the Board actually suggested the formation of an independent air force, or at least a General Headquarters (GHQ) Air Corps, which would give the air corps a level of autonomy within the army similar to what the Marines had within the navy. They also wrote that this air corps (or air force) should be capable of both bombing and anti-air missions.[107] The Morrow Board was convened soon afterward, and was much more influential though much more conservative, but it agreed with the Lassiter Board that the aircraft industry and the air service were in disrepair and needed to be strengthened.[108]

The civilian air sector reeled in the aftermath of World War I. Cancelled contracts and war surplus materials nearly dealt a death blow to the fledgling industry. This hurt military aircraft design as well, as military aviation had always relied on civilian air industry for both research and construction. By the mid-1920s, the industry was in danger of total collapse. In February 1925, civilian aviation got its first governmental boost with the passing of the Kelly Act. This act allowed the US Postal Service to contract out its air mail to private corporations, rather than being restricted to government aircraft. This allowed private corporations to begin building, selling, and buying new aircraft and new aircraft designs in order to gain government contracts. In addition, the Kelly Act inadvertently helped to bring about the creation of air travel

[107] David Johnson "From Frontier Constabulary to Modern Army: The US Army Between the World Wars," in *The Challenge of Change: Military Institutions and New Realities, 1918-1941*, ed. Harold Winton and David Mets (Lincoln, NB: University of Nebraska Press, 2000), 193.
[108] Johnson, "Modern Army," 193.

for civilians, as the mail rarely filled the aircrafts' cargo capacity and the remaining space was often given over to a few passengers.[109]

To continue its aid to civilian aviation, Congress passed the Air Commerce Act in 1926, which would permanently link civilian aircraft firms and military aircraft. This act approved new manufacturing contracts for civilian companies to design and build aircraft for the military. It ultimately led to a philosophy that military contracts were the best way to receive funding for research and development. This act, along with the Kelly Act, greatly increased the health of civilian aviation, which in turn proved very important to military aviation in the coming years, as civilian aviation became a hotbed of technical innovation. Several transport planes were modified to become bombers, and several bomber designs became transport and passenger aircraft.[110]

The Air Corps Act was also passed in 1926. This act officially created the army air corps, moving army aviation out from under the Signal Corps. This made sense from an organizational standpoint because the Signal Corps was responsible for army communications and reconnaissance, not combat. The creation of a separate corps for aviation gave army airmen a level of autonomy from the rest of the army and allowed them to pursue their own goals and methods. The act also increased the number of officers in the air corps from 900 to 1,514, increased enlisted men from 9,760 to 16,000 and mandated that the air corps must have 1,800

[109] Schatzburg, *Wings of Wood*, 97.
[110] Moy, *War Machines*, 44-49.

functioning aircraft at all times. The air corps chief of staff also reported directly to its own Assistant Secretary of War.[111]

Maj. Gen. Mason Patrick, who had been chief of the air service since 1921, was made chief of the air corps and did a great deal to create a culture separate from the army within the corps. The air corps became an extremely closed society. Having grown weary of bringing in senior officers from other divisions during his time in the air section and air service, Patrick made more of an effort to promote from within. He mandated that ninety percent of each officer grade within the corps must be certified pilots. Finally, with the founding of the air corps coming closely on the heels of what was considered by many air corps officers to be Gen. Mitchell's "martyrdom," the internal culture of the air corps became one heavily in favor of complete independence from the army; to think otherwise within the air corps quickly became career suicide.[112]

FINDING A PURPOSE

After gaining partial independence from the army, the new air corps focused on carving out a strategic niche for itself. The goal was to develop a role for the air corps that could not be replicated by another branch of the military in order to gain funding. This niche became strategic bombing. During World War I, the goal of the air service had been to support the infantry by strafing trenches and providing reconnaissance. The air corps wanted to depart from this role, and thus began to develop long-range bombers designed to attack enemies far behind the front

[111] Trubee Davidson, "Assistant Secretary of War Report" *Report of the Secretary of War to the President, 1928* (Washington DC: Government Printing Office, 1929), 87.
[112] Johnson, "Modern Army," 194.

lines in order to target cities and economic infrastructure rather than pure military targets. The air corps classified long-range bombers as defensive weapons, although they were clearly offensive.[113] They were able to justify this because of the air corps' other focus, coastal defense. The air corps justified these long-range bombers as being able to attack incoming ships, even if they were also intended to attack cities.[114]

The late 1920s heralded a minor revolution in the American aircraft industry, both for civilian and military aviation. Between 1928 and 1929, the total number of civilian air passengers surged by 335 percent and doubled again between 1929 and 1930. Between 1927 and 1933, the amount of miles flown by non-airmail aircraft increased from 638,000 miles to 10,860,000 miles.[115] This is an example of "Increasing Returns to Adoption," a technological concept which states that the more people who adopt a technology, the better and cheaper the technology gets. Commercial aircraft, not burdened by limited federal funding and isolationist policies (as the military was), actually leapt ahead of the military in the late 1920s into the early 1930s. In fact, by 1933, private airplane manufacturers had developed the basic commercial design that would last into the 1970s.[116]

During this period, the air corps relied nearly entirely on private contractors for new designs, doing virtually no internal research.[117] Most of the planes built in the late 1920s were

[113] Johnson, "Modern Army," 195.
[114] Nalty, *Winged Shield*, 116-121.
[115] *Final Report of War Department Special Committee on Army Air Corps*, (Washington DC:US Government Printing Office, 1934) 6.
[116] Schatzburg, *Wings of Wood*, 155-174.
[117] Ibid, 149-155.

old-style wood-and-cloth observation planes, and were still using Liberty engines built during World War I. These engines were "unreliable, inefficient, and uneconomical" and could not be used in newer, heavier aircraft.[118] In 1929, the air corps decided to promote all-metal designs exclusively rather than wood or wood-metal hybrid designs. Funding problems caused by trying to fund new aircraft while simultaneously expanding using existing designs kept the air corps from reaching this goal right away, but it did purchase two all-metal designs in the early 1930s: the Boeing YB-9 bomber, and the P-26 pursuit plane.[119]

The YB-9 was an example of civilian designs spilling over into military aviation. It was the first all-metal bomber ever purchased by the air corps.[120] The two-engine YB-9 was based heavily on the Boeing Model 200 Monomail single-engine cargo plane. The Monomail was, in turn, based upon the reports put out by the army and air corps regarding stressed-skinned wing design, internally braced wings, and Warren-truss rib design.[121] The only major differences between the Monomail and the YB-9 were the addition of a second engine, a change of engine location, and the purpose of the aircraft.[122] Only a few YB-9s were ever actually produced for the military, and the Boeing design eventually lost military bids to the Martin B-10. The B-10 was originally designed with a metal frame and cloth-covered wings, but entered production with

[118] Trubee Davidson, "Assistant Secretary of War Report" *Report of the Secretary of War to the President, 1928* (Washington DC: Government Printing Office, 1928), 68.
[119] Pursuit aircraft fulfill the same roles as fighter aircraft do today. The terminology changed in the late 1940s, although the Navy would adopt the Fighter moniker much earlier.
[120] Schatzburg, *Wings of Wood*, 154.
[121] Stressed-skinned designs allow the metal "skin" of the aircraft to contribute to load-bearing, allowing the aircraft to do away with internal support structures. Internally braced wings improve aerodynamics by moving the supports inside the wing. This is also called a "thick-wing." Warren-truss ribs make sure that the wing cannot twist or bend. The Warren Truss is a popular design for bridges due to sturdiness and stability.
[122] Schatzburg, *Wings of Wood*, 153

metal wings similar to that of the YB-9. The redesigned B-10 was slightly faster and had a higher lift-to-weight ratio, meaning it was able to carry heavier loads given its size. The B-10 was the first bomber with enough range and payload capacity produced in sufficient numbers (103 were ordered) to really make the goal of strategic bombing possible.[123]

Despite their bomber design not being purchased in large numbers, Boeing did win the contract to develop the P-26 in 1931 largely due to the initial success of the YB-9. The P-26 was the first all-metal single-wing airplane to be built in the same price range of a wooden biplane designed to play the same role. The P-26 performed significantly better than its wooden biplane predecessor, the Boeing P-12C. In addition, the P-26 actually cost less to build than the P-12C when it went into production in 1933; when the deflation caused by the Depression is factored in, the P-26 cost slightly more in materials, but still less in construction.[124]

THE GREAT DEPRESSION AND GROWING AUTONOMY

The Great Depression did not affect the air corps as much as it did the rest of the country or the other branches of the military. As seen above, many of the major advances in metal designs occurred during the first few years of the Great Depression, between 1929 and 1933. In 1931, Trubee Davison, the Assistant Secretary of War in charge of the air corps, reported that in terms of aircraft strength, the United States ranked fourth in the world *including* naval aircraft, and ranked fifth without them. He found this unacceptable and called for a substantial expansion

[123] Moy, *War Machines*, 69.
[124] "History: P-26 "Peashooter" Fighter," *Boeing Products*, http://www.boeing.com/history/boeing/p26.html

of the air corps.[125] In 1933, chief of staff MacArthur rejected a proposal to greatly expand the air corps beyond budgetary possibility, but did direct the deputy chief of staff, Gen. Hugh Drum, to convene a committee to review the air corps' expansion plans. The Drum Board also rejected the proposal, but did suggest the formulation of a General Headquarters (GHQ) Air Corps which would, if created, grant army aviation even more independence, similar to that of the marines in the navy. It would also allow the air corps to train and develop tactics independent of the army. The Drum Board was the first committee to suggest the creation of a GHQ for the air corps since the Lassiter Board in 1923.[126] The Drum Board also suggested a more realistic but substantial increase in the number of aircraft. However, these suggestions were not immediately acted upon due to the army's budget crisis.[127]

In 1934, the air corps and navy once again made a push for sole control of coastal defense. This led to a prolonged battle between Gen. MacArthur and the new navy chief of operations, Adm. William Standley. After months of talks and government intervention, they reached a compromise that was purposely vague and let both branches continue to claim responsibility over coastal defense.[128] The outcome of this ambiguous settlement was that the army had no choice but to grant the air corps more autonomy. It allowed the creation of a peacetime GHQ Air Corps in order to organize, deploy, and train the air corps as if war could begin at any moment, since it would be its responsibility (in the army's eyes, if not the navy's) to

[125] Trubee Davidson, "Assistant Secretary of War Report" *Report of the Secretary of War to the President, 1931* (Washington DC: Government Printing Office, 1931) 29-30.
[126] Douglas MacArthur, *Report of the Chief of Staff, US Army, 1934* (Washington, DC: United States Government Printing Office, 1934), 13.
[127] Nalty, *Winged Shield*, 120-121.
[128] Ibid, 121.

defend against a surprise attack upon the coastline. This also led to the long overdue cancellation of the Pershing-designed 9-element strike forces under the command of ground commanders. Instead, the GHQ Air Corps put the entirety of the air corps under the singular command of the chief of the air corps, second only to the army chief of staff.[129]

Before the GHQ could be organized, a crisis greatly stressed the air corps and hastened its formation. In early 1934, President Roosevelt cancelled the air mail contracts between the Post Office and the independent contractors licensed to deliver the mail, thanks to a Senate committee's findings of collusion and fraud on the part of the contractors. Roosevelt asked air corps chief of staff Benjamin Foulois if the air corps could temporarily handle the load. Foulois agreed without considering the implications of the task. It turned out to be an unmitigated disaster. Air corps pilots were not used to flying through harsh weather or at night; delivering the air mail required both of these things. Instruments such as artificial horizons, gyro compasses, and radios, although developed, were not in sufficient supply, so many of the pilots had to do without. In the twelve months the air corps handled the mail, there were twelve deaths, sixty-six crashes, and only a sixty-six percent completed delivery rate. Each of these deaths and crashes was also highly publicized, creating a perception that the air corps was incompetent.[130]

The disaster of the air mail project did result in some good. The use of instruments and instrumental flying became standard practice within the air corps. The use of radio communications while flying also proved to be important, and the air corps created a national air

[129] Nalty, *Winged Shield*, 122.
[130] Ibid, 123-125.

communication system, which would be officially established as the Army Airways Communication System in 1938. Also, the negative press of the disastrous airmail project was mitigated somewhat by the public, who could not believe that the air corps could have failed so miserably on its own; they called for the government to improve its funding and training.[131]

The government's response was to convene the 1935 Baker Board under Newton Baker, former Secretary of War. The Baker Board suggested much the same things as the earlier Drum Board, and expanded the air corps to 2,320 aircraft and 16,650 men. It also expedited the formation of the GHQ Air Corps, which, while approved, had not yet completed organizing. The Baker Report reiterated that a civilian aviation industry was "absolutely essential to the national defense."[132] This was not only for research purposes, but also because "military aviation in time of war must rely upon airplanes built in time of war and consequently the general condition and productive capacity of the aircraft industry are of national concern."[133] That same year the air corps received $45,000,000 from the Public Works Authority for new construction and research.[134] The air corps also received over $48 million independent of the army and an additional $22 million solely for aircraft purchase. It should be noted this was the same year that

[131] Nalty, *Winged Shield*, 125-126.
[132] *Final Report of War Department Special Committee on Army Air Corps*, (Washington DC:US Govt Printing Office, 1934) 19.
[133] *Final Report of War Department Special Committee on Army Air Corps*, (Washington DC:US Govt Printing Office, 1934) 19.
[134] Douglas MacArthur, *Report of the Chief of Staff, US Army, 1935* (Washington, DC: United States Government Printing Office, 1935), 22

the army's budget was cut by $100 million.[135] This clearly shows the government's commitment to military aviation.

The leadership of the air corps, after failing to gain complete independence despite support from both the Drum and Baker Boards, realized that the GHQ Air Corps was the closest it could reasonably come to independence for the time being. The GHQ Air Corps was officially activated in March 1935, ending the push for an air force until after World War II.[136]

THE RISE OF CIVILIAN AVIATION FIRMS

The NACA did not enjoy the same success as the air corps during the Depression years. In the wake of the stock market crash, it was accused, but never convicted, of corruption and profiteering. As a result of these accusations, the agency reorganized, focusing more on internal research rather than their initial advisory role. It combined some redundant research subcommittees in order to conserve funds and improve its public image. Despite its efforts, the NACA received no congressional funding from 1931-1937, although funds appropriated by the New Deal's Public Works funds would alleviate some of this budget shortfall.[137]

The NACA was called upon to justify its existence constantly throughout the 1930s. Because the NACA had moved away from advising and organizing and had focused on research, it seemed to be redundant when compared to the plethora of both civilian and governmental research firms and agencies focused on the advancement of air power. The NACA denied that it

[135] "U.S. President Asks Congress For More Cash," *Leader-Post*, Jan. 7, 1935, 5.
[136] Nalty, *Winged Shield*, 130.
[137] Roland, *Model Research*, 144.

had deviated from its purpose to advise and organize research; it responded by saying that, unlike civilian firms or individual military services, the NACA provided a forum for other research groups to discuss what they were doing, and therefore it actually prevented duplication of research. However, this distinction was often overlooked by congressmen and citizens, and in the public mind, the seeds of doubt had been sown. By the end of the 1930s, the NACA had lost its claim to being the being the best avionics research lab in the world. Domestic firms had taken the lead, as had other European firms. Despite the growing crisis in Europe, the NACA could not consistently overcome its enemies in Congress and by the end of the interwar period, the NACA had lost much of its relevancy as an avionics research organization.[138]

Civilian industry and academia took over much of the research from the flagging NACA. Much of the growth in these two sectors can be attributed to Daniel Guggenheim, a wealthy industrialist and philanthropist. Between 1926 and 1930, Guggenheim donated over two million dollars to various universities in order to establish and expand aeronautical engineering schools.[139] In 1926, Guggenheim founded the Daniel Guggenheim Fund for the Promotion of Aeronautics. This fund was an outgrowth of his already sizable contributions to New York University and focused on building aerospace programs in all areas of the country. The first universities selected were from the West and Midwest: the California Institution of Technology, Stanford University, and the University of Michigan. These universities already had small aeronautical schools with influential aircraft engineers. Guggenheim donated between $300,000

[138] Roland, *Model Research*, 146.
[139] Richard P Hallion,*The Legacy of Flight: The Guggenheim Contribution to American Aviation* (Seattle: University of Washington Press, 1977), 69.

and $500,000 to each school to greatly expand their programs.[140] Having donated money to universities on the West coast (Stanford and Cal Tech), the Midwest (Michigan) and New York (NYU), Guggenheim donated money to the Massachusetts Institute of Technology in December of 1926 and the University of Washington in 1928 in order to establish aeronautical schools in New England and the Pacific Northwest respectively.[141] The final school to be selected was the Georgia School of Technology (later the Georgia Institute of Technology) in 1930. Georgia Tech was the only school without an established aeronautical school, but its location and state funding made it the best choice for a Southern Guggenheim school.[142] In just over four years, Daniel Guggenheim had altered the landscape of aeronautics in academia. In 1926, there were only 96 aeronautical engineering students in the country, most of them enrolled at the first four Guggenheim schools. In 1930, when the fund expired, there were hundreds of students scattered across the country. In addition, the funds provided helped to build wind-tunnels at each of these schools, an essential piece of equipment for an aeronautics lab.[143] These schools remain some of the best aeronautical schools in the country; the top six aerospace engineering graduate schools in the country began as part of the Guggenheim Fund.[144]

[140] Hallion, *Guggenheim*, 45.
[141] Ibid, 55-56.
[142] Ibid, 59.
[143] Ibid, 70.
[144] "Best Engineering Schools: Aerospace / Aeronautical / Astronautical" *U.S. News & World Report*, March 18, 2011, http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-engineering-schools/aerospace-rankings

In addition to his contributions through the Guggenheim Fund, Daniel Guggenheim also made contributions to public grade schools to start aeronautical classes.[145] He gave grants to graduate students to travel abroad and to conduct independent research.[146]He gave numerous grants to fund the development of more accurate flying instruments. These instruments allowed pilots to "blind fly," meaning flying only using instruments in bad weather or at night.[147] Finally, he founded the "Safe Aircraft Competition."[148] Most airplane crashes at the time were caused by engines stalling at slow speeds and at low altitudes, which meant they usually stalled while trying to land. The Safe Aircraft Competition awarded $100,000 to the first aircraft designer to build an aircraft meeting the following specifications: the plane must land at less than 30mph on a less than 100-foot runway and must fly level at 35mph. In addition, the aircraft must reach a top speed of at least 110mph, climb at 400 feet-per-second, and have enough inherent stability to allow the pilot to take his hands off the controls for a full five minutes while travelling between 45mph and 100mph. Finally, extra points were given to any contestant who could outperform these specifications.[149] The results of this competition led to a revolution in landing safety by producing more stable avionics and technology that allowed aircraft to fly at slower speeds. An unexpected additional result was that the same technology that made landing safer also drastically shortened the distance an aircraft needed to take off. This would eventually lead to a

[145] Hallion, *Guggenheim*, 71.
[146] Ibid, 45.
[147] Ibid, 101-127.
[148] Ibid, 129.
[149] Ibid, 130-131.

type of wartime aircraft known at the Short-Takeoff-and-Landing (or STOL) aircraft. The ability to use very short runways made these aircraft useful in island landings and on city streets.[150]

Advances made by Guggenheim school graduates led to several major advances in long-range strategic bombing in the 1930s. In 1934, following the success of the YB-9 and B-10, the air corps set a contract reward for "Project A," a proposed bomber that would carry 2,000 pounds of bombs 5,000 miles at 200 mph.[151] The contract was awarded to Boeing later that year. Project A was designed as a long-term experimental design and was not meant to be a design-and-buy project.[152] While the first product of Project A, the XB-15 (X for experimental), was an operational failure (it could only fly 145 miles per hour fully loaded and barely travelled at 200 mph empty) it did contain a number of highly advanced systems. These systems included an autopilot, deicing installations (essential for a high-altitude bomber), fire-fighting equipment, electric generators, and passages within the wings that allowed for engine maintenance during flight.[153] In addition, because of the length of the flights it was designed to achieve, the XB-15 contained sleeping, toilet, and cooking facilities, as well as space for an onboard flight engineer. It could also carry 8,000 pounds of bombs--four times the amount of payload Project A required. Although the XB-15 was a technical "failure" in that it did not get built in large numbers, the plane did serve as a Red Cross cargo plane, and gave Boeing the experience needed to create a much more successful design: the B-17.[154] Project A was finally cancelled in 1945 and was a

[150] Hallion, *Guggenheim*, 150.
[151] Moy, *War Machines*, 70.
[152] Ibid, 72.
[153] Ibid, 71.
[154] Ibid, 70-71.

valuable experiment in terms of technological development, contributing heavily to the design of heavy bombers. In addition, the long-term project did much to cement the relationship between the air corps and civilian designers.

The bomber project that would lead to the B-17 actually began about the same time as Project A, and was designed to replace the B-10. The air corps did some fast talking to convince Congress to fund both Project A and another long-range bomber design simultaneously, but disguised the similarity by pitching Project A as a design for a bomber with long *range,* and phrasing the other project as a bomber with better *speed and efficiency*. Realistically, both of these amounted to a fast long-range bomber, but the B-10 replacement needed to be built as soon as possible, while Project A was a long-term project not designed to produce quick results. The distinction between range and efficiency was enough to gain funding for both projects. Boeing's experience with Project A gave it the advantage on the project by allowing them an inside look at what the air corps actually wanted, aside from the vague official description, which boiled down to "like the B-10, but better."[155]

The resulting XB-17 was a paragon of engineering when it entered the design phase and the interwar highpoint of the air corps drive to develop strategic bombing. It was streamlined, with all external systems either removed or integrated into the hull. All its weapons systems were enclosed, including machine guns and bomb racks. The plane also had retractable landing gear. The main body and wings were designed to distribute weight and stress evenly across the length of the plane, rather than on reinforced stress points. Redundant electric generators used to power

[155] Moy, *War Machines*, 72-73.

major systems, such as landing gear, bomb bay doors, and flaps, were spaced widely throughout the plane's fuselage and wings.[156] These design points made the B-17 extremely survivable in combat because it could take massive damage without tearing itself apart due to structural damage or losing systems due to power failure.[157] Numerous stories came out of World War II about B-17s remaining aloft and landing safely after sustaining major damage to the wings, fuselage, and tail. The popular joke was to just grab onto the biggest piece, and it would get you home.[158]

Although the reports coming out of Boeing headquarters convinced several air corps officers that the B-17 was the winner before it was ever built, other aviation companies were not willing to concede the contract. The Martin Company submitted a design that was essentially an improved B-10, with upgraded landing gear, autopilot, flaps, and radio equipment. Douglas also submitted a "bomberized" version of its DC-2 cargo plane, named the B-18 "Bolo."[159]

The B-17 was the clear favorite among the air corps' airmen due to its longer range and heavier payload, but it did have one major flaw: its cost. The B-17 was a giant aircraft for its time, and cost twice as much as the smaller B-18. The War Department and army chief of staff Craig were committed to providing the air corps with a certain amount of bombers, but felt they could fulfill that pledge for half the cost if they purchased the less-popular B-18. This also coincided with the government's isolationist policies; the range and payload capacity of the B-17

[156] Moy, *War Machines*, 74.
[157] Ibid, 74.
[158] Gladwin Hill, "Battered Fortress Brought Home After Heavy Damage" *The News and Courier, Charlestown, SC*, March 14, 1943, 10.
[159] Moy, *War Machines*, 74.

made it hard to fit into the official policy of "bombers for coastal defense" as it was clearly an offensive plane. With a range of over 2,000 miles, a B-17 could strike targets halfway across the Atlantic, which at the time was too far away to hit a moving target. In addition, B-17s optimal flight altitude was 7,000 feet, too high for an accurate strike against something as small as a battleship for aircraft carrier. When one of the XB-17 prototypes crashed due to pilot error in 1935, it gave the War Department the excuse it needed to buy 350 B-18 Bolos, and only thirteen B-17s. Airmen disliked the B-18, describing it as having a "strong affection for the ground."[160] The B-18 had a short and uneventful career and, with the growing threat of war, was being phased out of its bomber role by the early 1940s in favor of the B-17's stronger offensive capability.[161]

The rapid progress made in strategic bombers in the mid-to-late 1930s did not carry over to the fighter planes or pursuit aircraft. The P-26 was only slightly faster than the bombers it was designed to escort or attack, and was unable to intercept "attacking" bombers in a number of exercises. Several air corps officers, most notably Brig. Gen. Oscar Westover, assistant chief of the air corps, suggested removing pursuit aircraft from the air corps completely due to lack of performance. He also believed that they were not needed for escort duty, stating that bombers flying *en masse* in close formation would be able to successfully defend themselves from attacking aircraft.[162]

[160] Walter R. Close, "The B-18: a Reminiscence," *Aerospace Historian* 19, no. 2 (summer, 1982): 92.
[161] Moy, *War Machines*, 80.
[162] Nalty, *Winged Shield*, 140-141.

Pursuit fighters did have some support, especially from Capt. Claire Chennault. He stated that the P-26's inability to intercept its target bombers was caused more by the airplane's age in relation to its targets rather than the inherent invulnerability of the bombers, which was the air corps' official position. He also believed that the failure of the P-26 should inspire the air corps to *improve* their fighter aircraft rather than assuming that bombers could provide their own defense, and pointed to new foreign fighters as proof of the fighter aircraft's potential. Chennault was considered largely an annoyance to the air corps commanders and although he did influence the younger generation of fighter pilots, his beliefs would not become doctrine until World War II began and the vulnerability of the bomber squadron was proved.[163] At the end of the interwar period, the air corps had three planes in development to replace the P-26, but all of them were obsolete compared to their Japanese and German competition. The P-36 and P-40 were fast at low-altitude, but lacked the power for high-altitude flight necessary to attack bombers. The P-38 had the power necessary to go head-to-head with the Japanese and Germans, and was one of the better interceptors in World War II, but during this period it was plagued by mechanical problems.[164]

In late 1938, President Roosevelt called a meeting that resulted in legislation that would be known as the air corps' "Magna Carta." In this meeting, he called for the expansion of the air corps from 2,300 planes to 10,000, with the ability to purchase another 10,000 every year. Roosevelt's goal was to be able to put teeth behind any letters he sent to foreign governments, and because building an army was politically impossible due to the perception of the army as a

[163] Nalty, *Winged Shield*, 141.
[164] Ibid, 159.

solely offensive force, he would build an air force instead.[165] In March of 1939, Congress approved a budget of $358 million dollars for the air corps alone, a total larger than the army's budget the previous year.[166]

Military air power in America underwent an amazing transformation during the interwar period, going from a small collection of wood-and-fabric scouts to a fighting force of over 2000 all-metal aircraft capable of striking at an enemy over thousands of miles away. The organization of that air power had undergone a transformation as well, growing from a part of the signal corps to become a largely independent air corps, permitted to make many of its own policy decisions and able to train and organize as it saw fit.

Despite their successes, however, the air corps still lacked an air-superiority fighter at the end of the interwar period. Because of the overconfidence of the air corps' commanders, especially Oscar Westover, fighters and pursuit aircraft did not develop as quickly as bombers and lagged behind significantly. In addition, isolationist policies did hinder the air corps' ability to produce large bombers in significant numbers until the last year of the interwar period, due to the necessity of appearing defensive in nature to secure funding from the government.

The organization of the air corps played nearly as important a part to the advancement of aviation technology as the various research groups determined to advance it. As a part of the signal corps, airmen were expected to perform only scouting and infantry support missions, and therefore did not have much need for large long-range aircraft. As a semi-independent

[165] Moy, *War Machines*, 96.
[166] "US Defense Measure Increased $13,330,938," *Montreal Gazette*, Mar. 25, 1939, 1.

organization, the air corps pursued research avenues that may have gone unsearched otherwise. In addition, the air corps' interaction with civilian designers helped advance civil aviation as well, which then returned dividends back to the air corps. Unlike the rest of the army, which was hindered by isolationist policies and interdepartmental bickering, as well as funding shortages, the air corps had a unified command structure and was able to make critical advances despite the isolationist stance of the interwar period.

NAVY: BATTLESHIPS AND BOMBADIERS

America's return to isolationist policies following World War I and the adoption of international naval reduction treaty agreements almost immediately took their toll on the navy. Despite these restrictions, the navy was able to emerge from the period between the world wars with a comprehensive naval strategy and the technology to put that strategy into action. This era saw the development of many technologies and organizations that would be essential in World War II, such as purpose-built aircraft carriers, naval aviation, and radar. The navy managed this by reviewing its actions during and before World War I, identifying what it had done wrong, and learning to fix these problems, many of which mirrored the problems of the army. Following this step, the navy created a philosophy of quality over quantity to overcome the tonnage limitations imposed by the Washington Naval Treaty, and succeeded in developing in nearly every technological area before the end of the interwar period.

THE FORMATION OF THE TREATY SYSTEM AND THE NAVY'S REACTION

Navy policy emerging from World War I was uncoordinated and essentially revolved around a showdown between Adm. William Sims, known to be one of the major naval heroes of the war and commander of all naval forces in Europe, and Josephus Daniels, Secretary of the Navy. Sims had been rather outspoken in his contempt for Secretary Daniels during the war (largely due to the navy's and merchant marine's losses from German U-boats), and in response, Daniels launched a propaganda campaign against Sims in 1919. This culminated in Daniels promoting a senior naval officer over Sims for the position of Chief of Naval Operations. Daniels appointed Adm. Robert Coontz, who had no combat experience in the war and was junior to

Sims and several other wartime commanders.[167] Sims returned fire, attempting to destroy Daniels' reputation as a competent leader of the navy, and political factors made their rivalry a central point of the 1920 Naval Affairs Committee, a congressional body designed to review naval conduct during World War I.[168] However, Sims's obvious hatred of Daniels colored his testimony and allowed many senior officers in Washington to back Daniels, while Sims was backed by junior captains. The final Senate report was split between Republicans and Democrats, and nothing was really decided at the political level. Both parties were waiting for the elections of 1920, with Democrats waiting for a new leader and Republicans waiting for their turn to create a post-war policy.[169]

Within the navy, however, the Senate Naval Investigation bore fruit. The committee analyzed the actions of the navy before and during World War I, and the problems it saw mirrored those seen in the army: competing bureaus made the organization inefficient as a whole, the navy lacked a consistent policy, and also lacked up-to-date war plans.[170] In response to these findings, the navy called for the following changes: the navy needed to develop a single thinking and planning bureau; reorganization so that that all the bureaus were under the Chief of Naval Operations; the need for a commitment to research and development; that the navy prepare and organize for war at all times; and that the navy have a regular training schedule. In addition,

[167] Robert W. Love, Jr., *History of the U.S. Navy, Volume I, 1775-1941*, (Harrisburg: Stackpole Books, 1992), 522.
[168] Daniels had cleaned up the navy during his tenure, disallowing alcohol on ships and keeping brothels away from naval bases. He also founded the Naval Consulting Board, charged with designing new technology for the navy.
[169] Love, *History of the Navy*, 523.
[170] Tracy Kittredge, *Naval Lessons of the Great War: A Review of the Senate Naval Investigation of the Critisisms by Admiral Sims of the Policies and Methods of Josephus Daniels*, (Garden City, NY: Doubleday, Pagel, and Co, 1921), 451.

all senior staff officers must be qualified for their spots based on merit, rather than gaining high office for political reasons. As a result of these senate hearings, the navy avoided many of the same problems that plagued the army, which contributed to greater success in technological development.[171]

In the elections of 1920, Republicans emerged with the presidency and majorities in both congressional houses. This Republican victory opened the door to the isolationist treaty system that limited the navy's budget and numbers, and would affect naval policy for the next two decades. Republican leaders restated America's unwillingness to involve itself in European affairs, and subtly hinted at seeking a new balance of power in the Pacific Rim. European nations had lost a great deal of power in the Pacific, and America found itself as one of the dominant powers in the region, with the other being Japan. Initially the government planned to continue to follow the wartime naval expansion program begun by the Big Navy Act of 1916 and the Destroyer Act of 1917. The goal was to expand the navy to equal Britain's, which had 33 battleships and 9 battlecruisers to America's 16 battleships.[172] As a result, the navy retained a fairly high budget directly after the war: $396 million 1921, comparable to the army's despite containing only half the manpower and substantially higher, even after inflation, compared to its 1915 budget.[173] However, Senator William Borah of Idaho took the idea of International Disarmament from the Versailles Treaty and proposed its application to America's armed forces.

[171] Kittredge, *Naval Lessons*, 454.
[172] Battlecruisers are different from battleships primarily in terms of armor and speed. Battlecruisers have substantially less armor and are therefore much faster. In terms of armament they are quite similar. Love, *History of the Navy*, 526-527
[173] "Congress Faced With Budget Half Billion Below First Estimate," *Herald-Journal*, Dec. 6, 1921, 4.

In 1921, he advised adopting international treaties to set the maximum tonnage for the fleets of the Great Powers.

The British responded enthusiastically to the idea, and an international conference in Washington D.C. was set for 1921 and concluded in 1922. The primary goal for the Washington Naval Conference was to set limits to the total tonnage allowed for capital ships within the nations participating in the conference.[174] The current American naval war plans, under Plan ORANGE, assumed an offensive war with Japan, and assumed that the navy would lose 10% of its fighting ability for every 1,000 miles traveled in the open ocean. Using this ratio, the Americans came to the conclusion that they would need ten battleships for every six the Japanese had to retain a slight advantage, or a 10:6 ratio. The British demanded parity with the Americans, leading to a 10:10:6 ratio for the Americans, British, and Japanese respectively, which was simplified to the 5:5:3 agreement. In addition, the maximum size of a capital ship was set at 35,000 tons and could not have guns larger than 16-inches.[175] All other classes had to weigh in less than 10,000 tons and were limited to 8-inch guns.[176]

The signing nations believed that international competition would be minimized by this ratio system and the treaty was seen as a major success because it both halted America's rapid naval expansion and forced England to surrender her naval supremacy.[177] A ten-year halt to

[174] Capital ships are the main combat ships and include dreadnoughts, battleships, and battlecruisers.
[175] Guns are measured by the diameter of the shell designed to be fired from them. A 16-inch gun fires a shell with a 16-inch diameter.
[176] Philip Kaplan, *Battleships*, (Annapolis: Naval Institute Press, 2004) 47.
[177] Alfred L.P. Dennis, "Naval Armaments at Washington Conference; General Effect Good," *New York Times*, January 22, 1922.

battleship construction was included, prompting claims that the treaty sunk more battleships "than all the admirals of all the world would have sunk in a cycle of centuries."[178] The treaty limited the United States and Britain to 525,000 tons of battleships (or roughly 18 ships with a maximum tonnage of 35,000 tons). As a result, the navy was forced to decommission fifteen battleships and battlecruisers and effectively wasted over 300 million dollars.[179] In 1922, the navy scrapped 376 vessels or keels, including six battleships, 15 battlecruisers, one cruiser, eight mine layers, twenty-five eagles (a type of patrol ship), two gunboats, and one hundred seventy three destroyers.[180] However, the treaty allowed for 135,000 tons for aircraft carriers independent of the capital ship total. The naval budget also suffered greatly. In 1922, Congress cut the budget by $100 million and reduced the size of the navy by 20,000 men.[181]

The main goal for the navy over the next two decades became finding a way to circumvent the restrictions placed upon it by the Washington Naval Conference and subsequent budget cuts. The navy, with its quantity limited, had to focus instead on quality, and to do that it turned in large part to the development of technology, especially naval air power. In 1921, the Navy Joint Board reported, "It has become imperative as a matter of national defense to provide for the maximum possible development of aviation…in the navy," and in 1922, the Naval

[178] Love, *History of the Navy*, 530.
[179] Weigley, *American Way of War*, 244.
[180] Edwin Denby, *Annual Reports of the Navy Department*, (Washington DC: Government Printing Office, 1922), 8.; The larger ships or keels were scrapped due to treaty constraints. The smaller ships, such as the eagles and destroyers, were scrapped simply because the peacetime navy did not need as many of them.
[181] "President Offers a Reduced Budget, Sees 1924 Surplus," *The New York Times*, Dec. 5, 1922, 1.

Bureau of Aeronautics was established[182] Over the next two decades, naval air power would go from being a small cadre of pilots from World War I to a strategically relevant fighting force.[183]

THE RISE OF THE AIRCRAFT CARRIER

With the moratorium on battleship construction, the navy began focusing its construction on aircraft carriers. The first carriers built were essentially experimental modifications on existing ships; the top of a ship was removed and a deck installed in its place. Initially, naval aircraft made their mark by acting as spotters for battleship guns, and had enough success that their opponents were silenced and further experimenting was allowed. The first carrier to enter US service was the *Langley*, which was modified from the fleet supply ship (or collier) USS *Jupiter*. This first carrier had a number of innovative designs, including two aircraft catapults. However, it was only regarded as experimental and had a number of major design problems, especially smoke dispersal, slow launch-time for aircraft, and a small total amount of embarked aircraft. In addition, it was too slow to keep up with the older battleships, making it difficult for its aircraft to fulfill their reconnaissance role. Its sister ships were eventually relegated as "training carriers" to keep them out of the total tonnage allowable for carriers by the Washington Naval Treaty; however, the *Langley* remained in active service as a carrier until 1937.[184] The first two purpose-built carriers, the *Lexington* and *Saratoga* entered service in 1927.[185]

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[182] Edwin Denby, *Annual Reports of the Navy Department*, (Washington DC: Government Printing Office, 1921), 3.; Edwin Denby, *Annual Reports of the Navy Department*, (Washington DC: Government Printing Office, 1922), 21.
[183] Love, *History of the Navy*, 536.
[184]Norman Friedman *U.S. Aircraft Carriers: An Illustrated Design History*, (Annapolis, Naval Institute Press, 1989), 36-37.
[185] Love, *History of the Navy*, 237.

One of the major players in the development of early naval aviation came not from the navy, but from the army. William "Billy" Mitchell was the major proponent of an independent air force in the early 1920s, and this vision of an independent air force included all naval aviation as well. Mitchell believed that aerial warfare had become just as important as naval and ground warfare, and that to accomplish his goal of developing air power, all aircraft must be controlled by a central authority. In 1919 and 1920, he unsuccessfully attempted to gain control over aircraft carriers by classifying them as "air transports" rather than warships.[186] Thwarted on this front, Mitchell decided to prove that the battleship was obsolete and could be destroyed by aircraft. He formally challenged the navy to allow him to prove this. Pressure from both the general public and Congress forced the navy to perform the test in 1921. Mitchell did succeed in sinking three test battleships, but violated most of the limits that the navy had imposed. The navy complained about these violations and countered that a manned ship with anti-air and damage control crews may have been able to save the targeted ships. However, the writing was on the wall; Mitchell had succeeded in sinking the ships.[187]

The test did not succeed in the way Mitchell hoped, however. Rather than winning him control over ship-based aircraft, it instead forced the navy to develop its own aircraft in order to keep Mitchell out of their bailiwick. The navy organized its own Bureau of Aeronautics under the leadership of Rear Adm. William Moffett, whose career would be both longer and more

[186] Alfred F. Hurley, *Billy Mitchell: Crusader for Air Power*, (New York: Watts Aerospace Library, 1964), 49.
[187] Nalty, *Winged Shield,* 95.

successful than Mitchell's. Most importantly, the navy was able to keep control over its aircraft and aircraft carriers.[188]

Even more important to the foundation and advancement of naval aviation was Rear Adm. William Moffett. Moffett took over the navy's newly created Bureau of Aeronautics in 1921. Moffett was a decorated sailor at the time, with over thirty years in the navy and a Congressional Medal of Honor recipient. Prior to his appointment as the navy's head of aviation, Moffett's career solely consisted of surface warfare, most of it on battleships. His history as a battleship commander gave him credibility when he said that aviation must become a key component of naval strategy.[189] In a dramatically different approach to Mitchell, Moffett created a philosophy within the naval aviation community of "naval officer first, pilot second." This contrasted greatly with Mitchell's push for an independent air wing, and contributed to the reasons as to why naval aviation stayed part of the navy; the high commanders knew their pilots were loyal.[190] Moffett turned naval aviation into one of the best aviation programs in the world. The navy flew its first all-metal aircraft in 1922 and commissioned all-metal designs by 1925.[191] The navy also claimed the title of the first naval aviation program in the world to regularly use

[188] Hurley, *Crusader for Air Power*, 59-62.
[189] Col. Phillip S. Meilinger, *American Air Power Biography: A Survey of the Field*, http://www.airpower.maxwell.af.mil/airchronicles/cc/moff.html.
[190] Ibid.
[191] *United States Naval Aviation:1910-1970*, (Washington, DC: US Government Printing Office, 1970), 51.

catapults on aircraft carriers.[192] Moffett would continue to head the Bureau of Aviation until his death in an airship accident in 1933.[193]

BOMBERS OR BATTLESHIPS?

While the navy defended its air program from the air corps, it updated its battleships with new technology. Because of the Washington Conference, the navy was forbidden from building new battleships and was forced instead to update and upgrade the existing ships. The navy adopted a 7-year modernization plan, and designed most of the upgrades to protect the battleships from air attack. Unlike the air corps, the navy had an internal research organization, which allowed it to design many of these innovations and modernizations in-house, rather than using external contractors.[194] Six of the old coal-burning battleships were converted to oil-burning engines. This allowed the navy to concentrate on supplying its ships with one type of fuel, rather than having to transport both oil for new ships and coal for older ones. The oil-burning engines also proved to be much more powerful and efficient. Builders strengthened the decks of the ships and added more armor. To make guns better able to target aircraft, the navy redesigned and replaced them with guns able to be aimed higher. Catapults designed to throw reconnaissance planes into the air were installed. The first was installed on the battleship USS *Maryland* in 1922.[195] This new catapult design used smokeless powder rather than compressed air to accelerate aircraft. It was a much less cumbersome design and used new alloys that

[192] "Naval Aviation Is Handicapped by Lack of Men," *Sarasota Herald-Tribune*, Dec. 23, 1925, 16.
[193] "Admiral Moffett Lost, Only Three Survivors," *The Hartford Courant*, Apr. 5, 1933, 1.
[194] "To Cut Cost of Radio Broadcast," The Calgary Daily Herald, Aug 21, 1925, 21.
[195] Edwin Denby, *Annual Reports of the Navy Department*, (Washington DC: Government Printing Office, 1922), 21.

allowed higher pressures and temperatures.[196] "Duplex" radios were also developed. These radios were able to receive several different messages on the same antenna while simultaneously broadcasting. This allowed commanders a much better command and control ability while taking up less equipment space.[197] Finally, "blister compartments" were added below sea-level to protect from torpedo attacks.[198] The purpose of these compartments was not necessarily to protect against a physical bomb hit, but a near miss. A bomb that explodes near the ship at the waterline is actually more destructive because the explosion creates a shock wave, forcing the water around the explosion towards the target ship with great force.[199] All these advancements played a role in the navy's developing technological superiority.

The navy had to deal with an internal conflict of doctrines between advocates of the aircraft carrier and those who still favored the battleship as the main capital ship of the line. Because of the construction restrictions on battleships and battlecruisers, only aircraft carriers were built because they were the only capital ships the navy was permitted to build. However, the proponents of the battleship assumed that when the treaty expired in 1932, carrier construction would be replaced with battleship construction.[200] Carrier proponents disagreed. Lt. Comm. H.B. Grow, writing in the Naval Institute's publication *Proceedings* detailed the rather ambiguous compromise to this conflict in 1921: that the battleship would be in great danger if left unprotected by aircraft; but it still remained the main capital ship of the navy; that whichever

[196] Denby, *Annual Reports*, 25, 27.
[197] Ibid, 29.
[198] Love, *History of the Navy*, 543.
[199] Curtis Wilbur, *Annual Reports of the Navy Department*, (Washington DC: Government Printing Office, 1922), 34-35.
[200] Love, *History of the Navy*, 553.

fleet gained air superiority would most likely be the victor of a given engagement; that two 2,000-pound bombs would disable or destroy any ship; and that naval aviation would be essential to fleet protection and must be built to the limits of the Washington Treaty.[201]

Lt. Comm. O.C. Badger wrote that this was not the first time the battleship had been assumed obsolete; the same thing had been said of battleships when the torpedo boat was invented in the 1870s. The torpedo boat was a small, fast ship designed to get inside a battleship's defenses and launch torpedoes. They were somewhat effective, but the battleship was still around 60 years after its invention. Badger believed it would be much the same thing with the aircraft carrier and its airplanes. He also wrote that a carrier would be unable to take and hold a position like a battleship could and that aircraft were essentially raiders, not main combat units.[202] Essentially, it was agreed that the battleship would remain the main ship of the fleet, but the carrier would be an absolutely essential element in a battle group. Two years later, Lt. Forrest Sherman expanded on this point, writing that the carrier's main goal must be to launch aircraft to locate and destroy an enemy fleet's carriers in order to maintain air superiority.[203]

Highlighting the importance of air power to the navy was Comm. John Jackson of the US Navy. In 1922, he submitted a 101-point analysis of all things air to the US Naval Institute. His report included the capabilities of aircraft, types of aircraft, how to use aircraft (including

[201] Lt. Commander H.B. Grow, ""Bombing Tests on the *Virginia* and *New Jersey*," USNI *Proceedings*, XLIX (Dec., 1923.), 7.; *Proceedings* is a monthly periodical published by the US Navy. It details the major questions effecting the Navy and offers solutions for them. It also lists the major projects underway in the navy. Most of the contributors are active duty officers within the navy.
[202] Lt. Comm. O.C. Badger "History Repeats" *USNI Proceedings* 266 (1925): 707-760.
[203] Lt. F.P. Sherman, "Control of the Air," USNI *Proceedings*, (July, 1924)

scouting, fleet defense, and attack), the aircraft carriers' role as capital ships, the importance of maintaining air superiority, what types of bombs to develop, and what weapons systems aircraft should have.[204]

The first two carriers purpose-built for the navy were the *Saratoga* and the *Lexington*.[205] These ships, built from the keels of two battlecruisers on which construction had been stopped to meet the terms of the Washington Naval Treaty, massed around 33,000 tons and could carry between seventy-five to ninety aircraft of various types.[206] These carriers also had a small battery of 8-inch guns and smaller anti-aircraft guns, all of which could only fire to the starboard side due to the control tower on the port side. They also had the same blister compartments that had been previously installed on battleships. As these were the first purpose-built carriers, they underwent constant modification throughout their service careers, which included widening the deck, removing the catapults due to lack of use, and the addition of anti-aircraft machine guns.[207]

The *Lexington* and *Saratoga* caused a debate between the carrier proponents, those who favored building a few "heavy" carriers like the *Saratoga*-class and those who preferred a smaller "light" carrier.[208] As mentioned above, the navy was only permitted to build 135,000 tons of aircraft carriers, and the *Lexington* and *Saratoga* used up nearly half of that total tonnage.

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[204] Comm. John Jackson, "Employment and Tactics of Aircraft in Naval Warfare" *USNI Proceedings* 47 (1922): 1263-1297.
[205] Designated as the *Saratoga*-Class
[206] The two ships actually weighed in at around 35,500 tons, but a treaty loophole allowed 3,000 tons of defensive equipment, which allowed the carriers to come in below treaty limits. The Washington Treaty limited each nation to two carriers of over 27,000 tons, but no more than 33,000. Friedman, 43.
[207] Friedman, *Aircraft Carriers*, 44-47.
[208] A "class" refers to a ship design. Usually the class is named after the first ship built on a given design. For example, the *Nimitz* was the first of ten *Nimitz*-class carriers.

This meant that they would only be able to build 4-5 carriers of comparable size to a *Saratoga* (two 33,000-ton carriers and two or three 25-27,000-ton carriers), which limited the number of places the navy could deploy at a given time. The alternative was that the navy could build a larger number of light carriers with the remaining 69,000 available tons. The trade-off would be that their landing decks would be less stable (a lighter ship would be less able to stay level in heavy seas) and that they would hold fewer aircraft.

The navy designed a number of different carrier sizes to succeed the *Saratoga*-class, with each plan projected to allow a certain number of ships to be built. For example, the navy could build two 27,000 ton carriers, or five 13,800 ton carriers.[209] Having smaller carriers meant that each individual carrier would be less effective. However, having more carriers meant the navy could deploy carriers to more fleets, or even multiple carriers to the same fleet. The latter option would allow for some measure of redundancy should one carrier suffer damage, either due to attack or a mechanical failure. It is worth noting that these plans were only a debate while the naval treaties held. In the event of a war, tonnage would be unlimited and the navy would be free to build full-sized carriers.[210]

In 1930, a compromise was reached in the debate with the creation of the *Ranger*-class, a medium carrier about half the size of a *Saratoga* (14,500 tons), which could hold about eighty planes.[211] The carrier was able to carry this many aircraft because a larger percentage of its total size was committed to hanger space, allowing it to carry nearly as many aircraft as the much

[209] Friedman, *Aircraft Carriers*, 58.
[210] Ibid, 58.
[211] Love, *History of the Navy*, 543-545.

larger *Saratoga*.[212] In addition, the new design incorporated the flush-deck, a design used by British carriers, which had come to be preferred by American pilots. The flush-deck incorporated a wider deck, which made it the optimal design for launching aircraft and minimized the potential for landing accidents. However, it also necessitated the removal of the defensive guns, making the carrier dependent on its aircraft and the rest of the battle group for protection.[213]

NAVAL AVIATION SURGES AHEAD

While the navy was designing its second generation of purpose-built aircraft carriers, significant technological advances developed within naval aviation. This new wave of planes utilized the radial engine, an air-cooled engine developed for the air corps but adopted by the navy's Bureau of Aeronautics. The radial engine was reliable for over 300 hours of flight time between maintenance cycles, as opposed to earlier water-cooled engines which could only operate for fifty hours. In addition, the radial engines were more powerful and could operate at higher altitudes and for longer ranges. The additional power from the engine allowed aircraft engineers to shorten an aircraft's wings. This was ideal for the navy as shorter wings meant a smaller plane, thus making more room for additional aircraft on a given carrier. All-metal propellers were beginning to become standard, and the NACA-designed Roots Supercharger allowed for higher maximum altitudes and faster climbing.[214]

[212] Friedman, *Aircraft Carriers*, 70-71
[213] Ibid, 62-63.
[214] William Moffett, *Annual Reports of the Navy Department*, (Washington DC: Government Printing Office, 1925), 606.

Metal designs developed somewhat earlier in the navy than in the air corps for the very important reason that naval aircraft had to deal with water, while generally air corps aircraft did not. Properly treated metals have a much higher resistance to water damage than do wood and cloth, especially salt water.[215] Wood-and-cloth aircraft also absorbed water, weighing the aircraft down.[216] However, metal aircraft did prove much more difficult to repair. In the field, even minor damage could down-check an aircraft.[217]

In1925, the navy developed the PN-9 patrol plane. This was the navy's first aircraft made almost entirely of metal, rather than wood and cloth, and almost immediately set world records for endurance.[218] The navy considered long-range aerial reconnaissance crucial. They still considered Japan to be their primary potential adversary and needed the ability to scout vast stretches of the Pacific Ocean to locate Japanese fleets.[219] In 1926, the efficiency of air-cooled engines had increased by four-hundred percent over wartime engines, the size had been reduced by one-third their wartime size, and they had finally overtaken water-cooled engines in fuel economy and horsepower-to-weight ratio.[220] Also in 1926, the navy stopped purchasing new

[215] Baily Wright, *Flight: Construction and Maintenance, a General Survey of Fundamentals of Aviation*, (Chicago: American Technical Society, 1941), 136.
[216] Wright, *Fundamentals of Aviation*, 45.
[217] Ibid, 136.
[218] Moffett, *Navy Department 1925*, 605.
[219] Thomas C Hone and Trent Hone, *Battle Line: the United States Navy, 1919-1939* (Annapolis: Naval Institute Press, 2006), 96.
[220] Edward Eberle, *Annual Reports of the Navy Department*, (Washington DC: Government Printing Office, 1926), 34.

designs that were not entirely metal, although most of these new designs would not be seen until the 1930s.[221]

Because of these improvements in engine power and efficiency and the development of sturdier wings, dive bombing developed in this period, although it would not reach its full potential until the all-metal aircraft of the 1930s came into development. Once all-metal aircraft were developed, the additional strength given by the metal frame allowed aircraft to move faster and turn more sharply; both of these abilities are vital for dive-bombing. However, by 1927, it had become apparent that a few dive bombers could strike a battleship several times before the battleship's anti-air turrets (and, more specifically, its gunners) could target them. Adm. Sims claimed that a small fast carrier launching dive bombers with a 200-mile range could "destroy or disable a battleship alone" and the carrier was "a capital ship of much greater offensive power than any battleship."[222] Although a single dive bomber can only carry one 1000-pound bomb, it can hit its target with near-100 percent accuracy from a range of 150 miles. Battleships, on the other hand, could fire up to 16,000 tons of ordinance at a time. But at long range (approximately seventeen miles), it could only hit with 5% accuracy – about 800 pounds of explosives. This means, given one shot at a target, the dive bomber could deliver more ordinance at nearly ten times the range.[223] This had the additional effect of forcing battleship proponents to develop more effective anti-air batteries to counter possible air attacks.

[221] Eberle, *Annual Reports*, 36.
[222] Love, *History of the Navy*, 545-547.
[223] Hone, *Battleline*, 97.

Navy engineers also installed radiophones in aircraft near the end of the decade, which greatly improved the effectiveness of coordinated movements between aircraft and ships. By the end of the 1920s, navy strategists considered aircraft as primarily offensive weapons that should be used *en masse* against enemy carriers, preferably before enemy aircraft could be deployed. Commanders also considered aircraft the best *defense* against other aircraft, but anti-air cannons were being rapidly developed.[224] Lt. Comm. R.K. Turner developed a method of anti-aircraft fire control using multiple ships in order to maximize the chances of hitting a target aircraft, especially torpedo planes.[225] Because of this focus on both offense and defense, the navy made significantly more progress in the development of fighter aircraft than the air corps in the interwar period.[226] The navy also committed to funding large-scale training exercises to develop unified tactics between air and surface units. These exercises often contained large sections of the fleet and hundreds of aircraft, and were scheduled on a regular basis.[227]

THE LONDON NAVAL TREATY AND THE GREAT DEPRESSION

The last years of the 1920s saw the beginnings of a naval arms race in the development and construction of cruisers. Cruisers and destroyers were unaffected by the Washington Naval Treaty and were becoming bigger and more powerful, especially those built by the United States and Japan. The Butler Cruiser Acts of 1924 and 1929 allowed for the construction of several American cruisers and forced Britain and Japan to follow suit by building more cruisers of their

[224] Lt. Franklin Percival, "The Readjustment to New Weapons," *USNI Proceedings,* LV, (Aug, 1929.)
[225] Lt. Comm. R.K. Turner and Lt. T.D. Ruddock, "Gun Defense Against Torpedo Planes" *USNI Proceedings* 48 (1922): 1687-1695.
[226] Justin D. Murphy & Matthew A. McNiece, *Military Aircraft, 1919-1945: An Illustrated History of Their Impact,* Santa Barbara: ABC-CLIO, Inc., 2009), 22-23
[227] "Navy Organizes for Air Fleet Exercises," Milwaukee Sentinel, Jan. 18, 1928, 3.

own. The Geneva Conference in 1927 attempted to curtail this arms race before it really got started, but the three major powers, Japan, Britain, and America, were unable to reach an agreement as to the total tonnage allowed for cruisers, and Japan was reluctant to once again agree to a 5:5:3 ratio. As a result, the Conference achieved nothing, and building proceeded unabated.[228]

The onset of the Great Depression changed the dynamic of international naval relations. None of the major naval powers had the ability to keep the funding for naval construction at the level it had been previously, which made them more open to renewed discussions about limiting the tonnage and construction of cruisers. It even temporarily convinced the naval brass that budget cuts were unavoidable. The London Naval Conference of 1930 was convened to address these armament issues. The American diplomats disagreed with the navy in terms of the potential threat posed by Japan and did not believe that Japan posed a credible threat to China, let alone the rest of the Pacific.

As a result, the Americans, British, and Japanese reached a compromise, allowing the Americans to build 14 heavy cruisers between 1930 and 1936, with at least three to be built after 1934. Submarine tonnage would be equal between the powers, and a 10:10:7 ratio was set for destroyers.[229] The British attempted to downgrade the allowable tonnage of a cruiser from 10,000 tons to 7,000, but both Pacific powers rejected this plan. The navy saw the 10:10:7 compromise as a setback, believing that a 5:5:3 ratio was a necessity across all classes. However,

[228] Love, *History of theNavy*, 555-557.
[229] Ten for the British and Americans, seven for the Japanese

Chief of Naval Operations (CNO) Adm. William Pratt urged Congress to ratify the treaty. His reasoning was that both Japan and Britain had already reached their allotment for cruisers, and America would be able to build 14 more of them with the latest technology. The treaty gave "absolute parity" between the United States and Great Britain across all ship types and extended the agreements of the Washington Naval Conference for another five years.[230]

Despite opposition from the Navy League, a lobby of civilians and naval veterans dedicated to supporting the navy, the treaty was ratified. President Hoover then further slashed the naval budget and put a one-year halt on construction in 1932.[231] In addition, Hoover forced Pratt to separate the fleet into thirds, and rotate a third of the fleet into inactive reserves every year. This would save about fifty million dollars in operating costs, but would leave an already undermanned fleet even thinner.[232]

When Franklin Roosevelt took over the presidency in 1933, he brought a short attention span and an incomplete view of foreign affairs to the navy. The one good thing he did was appoint Senator Claude Swanson as the Secretary of the Navy. Swanson largely left the navy alone and let the admirals run it. His contributions to the navy consisted of lobbying for funding from Congress and building the navy up to its treaty limits.[233]

Initially, Roosevelt continued Hoover's policy of the one-third reserve, but his policy of deficit spending and Japan's continued aggression in China quickly brought it to an end. In the

[230] Webb Miller, "Stroke of Pen Marks Step to Disarm Fleets," *The Pittsburg Press*, April 22, 1930. 1.
[231] Love, *History of the Navy*, 558-565.
[232] Ibid, 589.
[233] Ibid, 585.

1933 National Industry Recovery Act (NIRA), Roosevelt earmarked $238 million dollars for naval construction. Thirty-three ships were planned, mostly destroyers, and both carriers and cruisers were built up to their treaty limits. Battleship modernization neared completion and the new CNO, Adm. William Standley, prepared to replace the navy's World War I-era battleships. The navy stated that this construction would employ over 18,000 Americans and would impact nearly every area of industry. In addition, 85 percent of the money spent on new construction went to pay the workers. This made the new construction easier to accept even by the more staunch isolationists.[234]

Rear Adm. Ernest King took over the Bureau of Aeronautics in 1933, when Rear Adm. Moffett was killed in a dirigible accident. King effectively ended the navy's airship program and began to focus on replacing the navy's remaining biplanes with the new metal monoplanes. Torpedo bombers were developed and used the new Norden bombsight. The Norden bombsight would be made famous by the US Army Air Force during World War II, but Norden originally designed it for the navy. The sight used a combination of an optical bombsight and an automatic pilot – up to this point, bombsights had been jury-rigged by the aircraft crew.[235] King also dismissed many of the carrier's secondary assignments such as reconnaissance, submarine hunting, and land attack, focusing instead on capital-ship assault and fleet defense.[236]

[234] "Approval of President is Given to the Cotton Code," *Schenectady Gazette*, July 8, 1933, 1.
"Japan Not to Abide by London Naval Treaty." *Lewiston Daily Sun*, June 29, 1936,1.
[235] Nalty, *Winged Shield*, 151.
[236] Love, *History of the Navy*, 589-591.

THE END OF THE TREATY FLEET

In 1934, Roosevelt authorized the construction of another 102 ships, with the belief that he would have to cancel the authorization after the Second London Naval Conference; the conference was to take place later that year. Japan denounced the Washington Naval Treaty in 1934, and made it perfectly clear that it would not renew the London Treaty of 1930. In December of 1935, when Japan demanded naval parity across all ship types, the conference rapidly fell apart. Japan walked out of the conference, and the United States, the United Kingdom, and France signed a weak treaty that in theory extended the terms of both the Washington and London Treaties for another decade, that none of the signing parties pretended to observe.[237]

Because Japan began to expand its navy without inhibitions imposed by international treaties, Roosevelt was forced to propose the 1935 Emergency Relief Act, which authorized the construction of an aircraft carrier, two cruisers, and various smaller types, and Congress increased the navy's budget to nearly $100 million over its pre-Washington Treaty budget, to $490 million, with $26 million earmarked specifically for naval aviation.[238] Britain soon backed out of the largely meaningless Second London Naval Treaty in 1936, and all the major naval powers were free to build as many ships as they pleased at whatever size they wished as of January 1st, 1936.[239]

[237] Hone, *Battleline*, 16-17.
[238] "U.S. President Asks Congress For More Cash," *Leader-Post*, Jan. 7, 1935, 5.
[239] "All Navy Treaties Ending Tomorrow," Montreal Gazette, Dec. 30, 1936, 3.

In January 1936, Roosevelt announced plans to build a navy able to defend the country from an offensive war, and that he would begin construction on two new battleships, the first new battleships to be built in nearly two decades.[240] These two battleships would be of the *North Carolina*-class, a brand new class of battleship, and would be built with 16-inch guns as opposed to the 14-inch guns allowed by the treaties. This was permissible because the treaties had an escape clause written in allowing other nations to break said treaties once another nation had. Because Japan was building battleships with 16-inch guns, nothing prevented America and Britain from doing so as well.

By this point, it was increasingly obvious that a war, or at the very least a showdown, between Japan and the United States was brewing. However, the navy had collectively believed a Pacific war had been inevitable for decades.[241] European nations began to rearm as well, especially Britain and Germany. Japanese expansionism into China was becoming more pronounced. However, Roosevelt was unprepared to do anything about it in 1936, and his "strategic planning" was often inconsistent and nonsensical.

By the end of 1938, the US Navy had a total of 533 warships, a 100-ship increase from the year before. Most of these ships were built out of the funds granted by the Emergency Relief Act and the NIRA, and included three carriers: the *Yorktown*, the *Enterprise*, and the *Wasp*. This allowed the navy to focus on new battleships, and Roosevelt approved funding to build two new *South Dakota*-class battleships per year for two years. After two years, newer classes were

[240] Love, *History of the Navy*, 593-594.
[241] "War or Peace in the Pacific," *New York Times*, July, 10, 1921, 1.

developed and the navy stopped producing *South Dakota*-class ships. In addition, funding was received for two *Hornet*-class carriers, nine cruisers, twenty-three destroyers, two submarines, and one thousand aircraft.[242] Finally, in 1939, Congress approved the construction of two *Iowa*-class battleships and the widening of the Panama Canal to allow these new ships to use it, in addition to a budget of $770,473,241. These *Iowa*-class ships were arguably the most successful battleships in history, as they remained in service for nearly 50 years, and their nine 16-inch main cannons gave them one of the most powerful broadsides of the war.[243]

There were a number of issues in the development of technology during this final period, and many of them were the fault of politicians rather than the navy itself. Because of the large push to produce capital ships such as battleships and large carriers to prepare for war, the navy largely ignored the construction of lighter ships, especially cruisers; between 1936 and 1939, only one additional cruiser was laid down for construction. This is somewhat understandable, as the newest battleship in the fleet was built in 1918 – most of the cruisers and all of the carriers were a decade younger.[244] The result was a fleet full of fast, modern battleships, but very few new lighter units that were needed to protect them. In fact, the new battleships could outrun these smaller units, meaning that they must either slow down to allow the support ships to keep pace, or travel without a protective screen of smaller ships. In addition, aircraft carriers were still relegated to designs drawn up under the treaty program, meaning that their size was restricted.

[242] Love, *History of the Navy*, 607.
[243] "770,473,241 For US Navy Recommended," *Meriden Daily Journal*, May 4, 1939, 1.
[244] Love, *History of the Navy*, 620.

The end of the treaties meant the end of these restrictions, but new designs lagged behind due to the renewed focus on battleships.[245]

Despite the priority shifting away from smaller ships in the late 1930s, there were many new technological innovations that were implemented on the new construction. Radar was installed on several destroyers and cruisers (as well as on four battleships) in order to spot incoming aircraft, although doctrine would not be established on its use until the war. The Mark XIV torpedo was developed with a range of over 9,000 yards and a top speed of nearly fifty knots. In addition, it no longer relied on impact to detonate; instead, it had a "magnetic exploder," or proximity fuse, which allowed the torpedo to do damage on direct hits *and* near misses. All these new technologies would greatly influence and aid the navy's war-fighting ability during World War II.[246]

The largest gap in naval preparedness coming out of the interwar period was in support ships. After the collapse of the naval disarmament treaties, carriers and battleships were built stronger and faster than ever before. In the case of battleships, they were fast enough to outrun their own screen. Eight of these fast battleships were laid down between 1936 and 1939, but only one cruiser fast enough to keep up was authorized for construction. This left the navy critically unprepared numerically to fight a two-ocean war.[247]

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[245] Love, *History of the Navy*, 630.
[246] Love, *History of the Navy*, 637.
[247] "New Battleships Are Named *Iowa* and *New Jersey*," *Evening Independent*, July 12, 1939, 6.

In addition, the possibility of a two-ocean war came as a surprise to the US Navy. Since World War I, the navy had focused on Japan as its most-likely opponent and had planned its strategy around that fact in Plan ORANGE. The rise in European tensions forced a paradigm shift in the navy and Plan ORANGE was scrapped in favor of the new RAINBOW Plans, which were designed to meet a number of different possible conflicts, including a simultaneous war in the Atlantic and the Pacific. These new plans required a larger navy, and those numbers would not be available until after World War II began.[248]

Despite not being prepared numerically, the navy had all the technology it would need to fight World War II on equal terms. It had both modern aircraft carriers and battleships and the technology to build the ships needed to support them (although the number built was small). The blame for the navy's lack of numerical power can be laid at the feet of isolationist politicians and later, Roosevelt himself, as well as the disarmament treaties to which the navy had, in part, agreed. Despite the isolationists' attempt to limit the navy's fighting power, it had developed and deployed the aircraft carrier in order to make up for the limited tonnage it was allowed. The navy had devised a cohesive strategy for both aircraft and surface ships to work together. Finally, the ships that the navy was permitted to build both during and after the treaty system were some of the most modern in the world, and those built before the treaty system were constantly updated with new technology to keep them as modern as possible. Also, when war appeared on the horizon, the United States was prepared to initiate a massive building program to bring the navy up to strength. Because of this, the navy was able to enter World War II having developed nearly

[248] "American Need is 2-Ocean Navy," *The Spokesman Review*, July 18, 1939, 17.

all the technology it would need to effectively fight a two-ocean war. The only remaining task was to deploy the new technologies together *en masse*.

CONCLUSION

The twenty year period between the world wars heralded in an astounding number of new technologies. The army, air corps, and navy, to varying degrees of success, all made progress on a number of technological fronts between 1919 and 1939. They did this despite the plethora of barriers erected in their path, be they political, budgetary, or organizational. The success or failure of these military branches to develop new technology cannot be accounted for simply by funding, individuals, or organizations, but rather, by a combination of all these factors.

The army was the branch most adversely affected by Congress's isolationist policies, organizational inefficiency, and budget cuts. The National Defense Act of 1920 not only severely cut both the army's manpower and budget, but also brought back an organizational system that had proven inefficient and had been replaced by a more effective, top-down structure. The actions taken by Congress set the tone for the rest of the interwar period for the army, by not allowing it the manpower to properly perform its duties and reinstituting an obsolete command strategy and giving power back to the department heads, rather than consolidating power in the army chief of staff as Gen. Peyton March envisioned. Although most of the chiefs of staff during the interwar period favored modernization of the army, many of the department heads did not. This was further exacerbated by a lack of proper funding, making it nearly impossible for the army to manufacture any technological gains they did achieve. The two tanks designed in the 1920s, the Medium A and the Christie, were put aside in favor of the armored car at the discretion of the chief of the infantry division. The standard firearm for the army was still the 1903 Springfield, despite the development of the M1. Finally, due to the lack of a standard truck

design and a slashed training budget, in addition to obsolete weaponry, the army failed to form a cohesive strategy involving mechanized weaponry and motorized transport. At the end of the interwar period, the army had not made significant progress on tanks, artillery, mechanization, or small arms. What little modern material it did have were in short supply and largely untested in the field.

The air corps, despite being part of the army, finished the interwar period in stark contrast to its parent branch. By partially separating itself from the army, it overcame many of the army's organizational inefficiencies, and a good marketing campaign allowed the air corps to gain funding to develop "defensive" strategic bombers. Billy Mitchell's influence on the air service at the end of World War I gave the army airmen a sense of purpose and identity. His publicity stunts made the air service, the public, and the government aware of the potential of military aircraft, be it defending the heartland or sinking battleships off the coast. Even after Mitchell's resignation, the air service and later the air corps remained a cohesive unit under the leadership of Gen. Mason Patrick and his successors.

After the formation of the air corps, Patrick made army aviation a nearly closed society, promoting from within, forming a culture, and setting goals apart from the army. Because of this unified command structure and a cohesive goal, it was able to find a niche for itself within the army and then pitch itself as a defensive organization apart from the army. The idea of strategic bombing (being able to attack targets far behind enemy lines), was very appealing to the military establishment. Even more importantly, being able to market this idea with the purpose of

defending the coastline, rather than attacking cities, made the air corps politically viable. These changes in presentation allowed the air corps to secure funding independent of the rest of the army.

Using a combination of this funding, plus government organizations such as the NACA and private corporations such as the Martin Company and Boeing, the air corps made significant technological progress, advancing from wood-and-cloth aircraft at the beginning of the 1920s to all-metal, single-wing aircraft at the end of the 1930s. However, the air corps did not make significant advancements in fighter aircraft until the very end of the interwar period, assuming that its bombers would be able to either outfly or outgun any defenders. The fighters it did have were either too slow to keep up with the new bombers, or too underpowered to reach the altitudes where bombers flew. The P-38 would eventually become a serviceable fighter during World War II, but at the end of the 1930s it was still a test project plagued with mechanical problems. Overall, the air corps made significant progress during the interwar period, but there remained some oversights in 1939.

The navy began the Great War with several of the same problems as the army: a system of bureaus dominated the command structure and a culture of treating peacetime and wartime differently in terms of preparation and readiness. At the end of World War I, the navy dealt with these problems immediately during the 1920 Senate Naval Investigation, taking power from the bureau chiefs and giving it to the chief of naval operations. In addition, they committed themselves to preparing for war at all times through constant upgrades and regularly scheduled,

large-scale training exercises. These organizational factors allowed the navy to overcome both funding deficits and tonnage limits.

In the wake of World War I, the navy was affected by a series of international treaties designed to weaken navies to the point that they could not be used offensively. As a result, tonnages were strictly limited for capital ships, such as battleships, battlecruisers, and aircraft carriers. In 1930, smaller ships such as cruisers and destroyers became limited as well. Ironically, these two treaties actually fostered many technological innovations. The navy responded to these handicaps by forming a culture of quality over quantity. Existing ships were upgraded constantly during the interwar period with better guns, armor, and engines. The navy converted almost entirely to oil-based engines, rather than coal-fired engines.

In addition, the navy began to further develop the aircraft carrier, especially after Billy Mitchell's tests proved that aircraft could sink battleships. These carriers had to conform to a compromise between holding enough aircraft to be effective, and fitting into tonnage limits to allow the navy to build enough of them to put at least one carrier in each fleet. As a result, the carriers built in the interwar period were somewhat undersized, but contained all the design elements needed to build full-sized carriers once the naval treaties fell apart in the mid-1930s. The navy also developed their own aircraft independent of the air corps, designed to defend and attack ships. Because of these different goals, the navy actually developed better fighter aircraft than the air corps prior to World War II. The navy also developed all-metal aircraft long before the air corps, due to metal's superior durability in water.

Because of naval command's obsession with improving the quality of its hardware during the 1920s and 1930s, when the naval treaties dissolved, the navy was prepared to build entirely modern battleships that were stronger, faster, and better armed than ever. However, due to the twenty-year hiatus on battleship construction, the navy focused solely on building battleships for the final years before World War II. They built no new carriers and very few smaller ships like cruisers and destroyers, leaving them with a small number of modern ships of these types. This was not a technological oversight, however. All the technology was available to build larger aircraft carriers and faster cruisers; the navy simply had not built them yet.

The argument could be made for either the navy or the air corps in terms of which service improved most technologically between 1919 and 1939. Both the air corps and the navy considered the development of cutting-edge aircraft critical. The navy developed an entirely new class of ship, the aircraft carrier, to transport and launch these new aircraft. It also vastly improved the performance of its more conventional arsenal despite the restrictions placed upon it by the international naval treaties and budget constraints. The air corps, on the other hand, effectively invented itself out of nothing, starting as the air service, a division of the signal corps, in 1919 to being a largely independent military branch in 1939. Technologically, it had advanced from being a small group of wood and cloth observational biplanes to a significant force of all-metal bombers.

The army, hardest hit by budget cuts and manpower restrictions do to isolationist domestic policies, was also the clear loser in terms of technological development. Most of the

army still used the same weaponry as they had at the end of World War I for both artillery and small-arms. What few technological developments that were made were not produced in large quantity and were never tested in large-scale maneuvers. As a result, the army ended the interwar period largely unprepared for World War II.

There are a number of comparisons to be drawn between the interwar period and the current military situation. With a tenuous economy and the potential for upcoming budget cuts to the military, it is more important than ever for today's commanders to look to the past to see what mistakes were made, which were averted, and the best ways to maintain a strong and prepared military presence. In the face of budgetary shortfalls, the most important factor is to have a unified command structure, headed by one department, rather than having a collective of different bureaus interested only on pursuing their own agenda at the expense of all others. Equally as important is having common goals throughout the organization. In the air corps, it was carving out a specialized niche, followed by the development of strategic bombing. In the navy, the goal became to be ready for war with cutting edge weaponry, despite the challenge of international treaties and budget cuts. Finally, many interwar success stories were due to civilian agencies and corporations working with and for the military. The air corps and navy each realized that the private sector could be a boon to a research and development programs. Both the air corps and navy relied heavily on civilian aviation to develop new aircraft and associated technologies. United, these lessons as learned from the interwar period provide not only explanations for differing levels of success by each branch, but also provide a blueprint for future technological development for today's military, regardless of obstacles.

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