AIRSHIP ADVOCATES: INNOVATION IN THE UNITED STATES NAVY'S RIGID AIRSHIP PROGRAM

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Abstract of Dissertation

Airship Advocates: Innovation in the United States Navy's Rigid Airship Program

In the decades leading up to the First World War, aviation enthusiasts and interested publics around the world watched as aviation developed in two directions, supporting heavier-than-air airplanes, and lighter-than-air airships. The airships, which relied on buoyant gases to maintain altitude, provided unique commercial and military capability. They were employed by several countries during the war, and at the war's conclusion, became the target of interest for United States Navy planners and strategists. Over the decade and a half following the First World War, advocates at all levels of the United States Navy pushed the Navy to adopt and employ the new technology.

This research examines the navy's rigid airship experience as a case study of failed innovation. Employing innovation theories from history, sociology, and military studies, this research explores the roles of four key airship advocates within the Navy's organizational structure. Each of these advocates approached innovation and the advocacy of a new technology from a different perspective, with varying results. Despite its apparent ability to fulfill operational and strategic requirements, the United States Navy began turning its support away from the airship in 1926, only three years after the first airship's maiden flight.

This study found that existing innovation theories are insufficient to explain the failure of rigid airship technology in the United States Navy. Instead, this work found that

competing technologies, concepts, and a misunderstanding of the limited innovation timeline hampered the advocates' efforts.

Table of Contents

Chapter 1: Introduction

In the decades leading up to the First World War, aviation enthusiasts and interested publics around the world were taken by an airship fever. William F. Trimble, in his biography of Admiral Moffett, suggests that, "Few technical developments generated as much interest and controversy during the twenties and thirties as the rigid airship."[1] For the American public, the pre-war airship was seen as a marvel of modern technology. Futuristic visions of American cities invariably included passenger and freight dirigibles landing on skyscrapers, and rigid airships destined for far-off lands such as Europe, the Panama Canal, and the North Pole.[2] While Americans dreamed of a floating future, military leaders saw the wartime potential for new types of airships as cargo carriers, scouts, and even bombers.

The airship, a lighter-than-air craft, predates the heavier-than-air airplane by more than a century.[3] French and German engineers developed balloons from simple devices to provide lift into controllable conveyances, or dirigibles.[4] The first airships were non-rigid, that is, contained no superstructure inside the balloon or 'envelope.' By the late 1800s, the three major elements of the modern airship were in use: interior ballonets to maintain the

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[1] William F. Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, Smithsonian History of Aviation Series (Washington: Smithsonian Institution Press, 1994), 13.

[2] For illustrations of futuristic cityscapes with dirigibles see Joseph J. Corn, *Imagining Tomorrow: History, Technology, and the American Future* (Cambridge, Mass.: MIT Press, 1986), 166, 168, 180-181.

[3] For a useful short summary of the history of airship development see William F. Althoff, *Sky Ships: A History of the Airship in the United States Navy* (Pacifica, Calif.: Pacifica Press, 1994).and Guy Hartcup, *The Achievement of the Airship: A History of the Development of Rigid, Semi-Rigid, and Non-Rigid Airships* (Newton Abbot; North Pomfret, Vt.: David & Charles, 1974).

[4] Dirigible is a French term meaning controllable, or directable.

shape of the envelope during ascent and descent, ballast to control ascent and descent, and a lightweight engine.[5]

Under Count Ferdinand von Zeppelin's leadership, the first Zeppelin airship made her maiden voyage in 1909. Between 1910 and 1914 the Zeppelin Company flew almost sixteen hundred flights, marked thirty-two hundred hours aloft, and transported more than 10,000 passengers without a single injury.[6] American public attention, as well as that of the United States Navy, was firmly fixed on the enormous vessels. By 1913, Admiral David W. Taylor, Chief of the navy's Bureau of Construction and Repair, had decided to encourage airship development in the navy by sending one of his naval officers, Jerome C. Hunsaker, to Germany to observe and report on developments.

When the First World War began, American naval airshipmen went to Great Britain for training on British systems. During the war British airships appeared to prove their worth in wartime operations. According to one source, "The airship's greatest value to the Allies during the past war was in convoy work. Indeed, it was common knowledge that a submarine would not attack a convoy escorted by airships."[7] The American Navy, convinced of the value of the craft, began acquisition of non-rigid airships as well as training of airshipmen in 1915. By August 1917 the first class of lighter-than-air pilots were designated Naval Aviators (Dirigibles).[8]

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5 Hartcup, 30-31.

6 Frederick Lewis Allen, *Only Yesterday: An Informal History of the 1920's*, 1st Perennial classics ed. (New York: Perennial Classics, 2000), 181. Cited in Althoff, *Sky Ships: A History of the Airship in the United States Navy*, 1.

7 "Notes on the Operation of Nonrigid Airships," (Washington, DC: Government Printing Office, 1920), 10. Cited in Althoff, *Sky Ships: A History of the Airship in the United States Navy*, 6.

8 Arthur Frederick Daubeney Eveleigh-de Moleyns Ventry and Eugáene M. Koleâsnik, *Airship Saga: The History of Airships Seen through the Eyes of the Men Who Designed, Built, and Flew Them* (Poole, Dorset

John Duggan, author of *Airships in International Affairs*, points out that the U.S. Navy's experience in World War One, especially in regards to aviation, had been diffused and disunited by a mixture of approaches. Before the war, the navy had not yet decided whether lighter-than-air, or heavier-than-air aviation would be its focus.[9] The army, under General Billy Mitchell, made an attempt to draw lighter-than-air aviation into its purview. By 1919, however, the navy had been chosen as the nation's lead agent for rigid airship development and experimentation.[10] Congress authorized the construction of a naval station to build and operate rigid airships, and the funding to procure two of the aircraft. The initial approach was to draw on foreign expertise in construction and development.

Through the Treaty of Versailles the United States Navy was allowed two American naval officers as observers on every flight of the Graf Zeppelin, flagship of the German Zeppelin Corporation.[11] The Treaty also provided for German Zeppelins to be turned over to the United States. When they were instead destroyed by their German crews, the United States government sought and obtained a new airship, the ZR3, *USS Los Angeles*, from the Zeppelin factories. In addition to the German Zeppelin, the navy decided to procure one airship (ZR2) in England and construct the other (ZR1, *USS Shenandoah*) at the new station in Lakehurst, New Jersey. ZR2 (British R-38) was never christened in the

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New York, N.Y.: Blandford Press;

Distributed in the U.S. by Sterling Pub., 1982), 142.

[9] John Duggan and Henry Cord Meyer, *Airships in International Affairs, 1890-1940* (Houndmills, Basingstoke, Hampshire; New York: Palgrave, 2001).

[10] Douglas Hill Robinson and Charles L. Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935* (Annapolis, Md.: Naval Institute Press, 1982), 118. cited in Duggan and Meyer, 72.

[11] E. T. Wooldridge, *The Golden Age Remembered: U.S. Naval Aviation, 1919-1941* (Annapolis, Md.: Naval Institute Press, 1998), 150.

United States Navy and did not complete her flight trials before crashing, an accident that killed forty-four, including sixteen of the U.S. Navy's most experienced airshipmen.[12]

The nineteen twenties and thirties saw the development, flight, and rapid demise of the large rigid airship program in the U.S. Navy. Between 1921, when the first large rigid airship took its maiden voyage, and 1935, when the last flew, army and navy leadership, Congress, and airship advocates both within and outside the government struggled over control of the new technology. Their struggles and viewpoints have not been well-documented. Theodore Roscoe, author of *On the Seas and in the Skies: a History of the U.S. Navy's Airpower*, attests that, "to this day the big dirigible story constitutes one of the least-known chapters of American naval history."[13]

This dissertation will deal with the experimentation and organizational interactions surrounding the development and testing of the 'Four Giants,' the United States Navy airships *Shenandoah*, *Los Angeles*, *Akron* and *Macon*. The *Shenandoah*'s first flight was in 1923, and the *Macon's* last flight was in 1935. Table one below provides basic dates for each of the five large rigid airships procured by the navy.

Airship Designator	Airship Name	Maiden Voyage	Last Voyage
ZR1	*USS Shenandoah*	1923	1925
ZR2	Not christened	1921	1921
ZR3	*USS Los Angeles*	1924	1932
ZRS4	*USS Akron*	1931	1933

[12] Ventry and Koleâsnik, 143.

[13] Theodore Roscoe, *On the Seas and in the Skies; a History of the U.S. Navy's Air Power* (New York: Hawthorn Books, 1970), 176.

ZRS5	*USS Macon*	1933	1935

Table 1: Airships of the United States Navy

Approach

The objective of this dissertation is to examine the development and eventual rejection of large rigid airships within the United States Navy as a case study of military innovation. The rigid airship had only a limited tenure with the United States Navy and was never integrated into major warfare or war plans. In this way, the airship is most often categorized as a failed innovation. My particular interest is in understanding how a small group of individuals interacts with the larger organization, in this case, the United States Navy, to push, facilitate, or even hamper change.

The approach proposed for this dissertation is to examine the experience of four individuals who had a unique perspective, and in most cases, important role, in the U.S. Navy's rigid airship program. The intent is not to imply that these four are the sole key individuals who were relevant to the airship's development. Not only the navy, but also the army, the National Advisory Council for Aviation, and commercial organizations such as Goodyear and Alcoa played a strong role in the American airship story.

Because the development of airship requirements, the assessment of airships as a strategic and operational weapon, and the eventual decision to halt funding lay in the hands of the United States Navy, I have chosen to focus on five naval officers rather than focusing on the views of other key players. The four I have chosen were also all supporters of the new technology, airship advocates. They testified before Congress and the navy General Board and published in the trade press arguing for navy support of large airships.

Within and across the archives of these four individuals there is a story that provides insights into the path of rigid airships in the U.S. Navy and perhaps also failed innovation and military innovation writ large. Each of the four individuals under study went through the American rigid airship period at a different point in his naval career, from George H. Mills's years as a Lieutenant in training to Admiral Moffett's tenure as Chief of the Bureau of Aeronautics. This variety in organizational placement is also intentional, as I hope that a variety of perspectives will provide a better view of the organization as a whole.

All the individuals under study were also naval officers, rather than enlisted men. This is in part a forced decision as there are few extant archives from enlisted airshipmen. Also, major decisions regarding airship development and employment were made not among enlisted, but rather within the officer ranks.

There have been many studies of successful military innovations, most notably Murray and Millet's *Innovation in the Interwar Period*. However, there is little work on failed innovations, or innovations that did not lead directly to operational employment. The case of the airship is particularly interesting as a failed innovation because it was one of the few new technologies to be so thoroughly explored, constructed, manned, and deployed but never employed in a wartime environment. Richard Smith describes it as, "the first multimillion-dollar weapons system born of twentieth-century technology which was terminated without being tested in combat, and allowed to pass out of existence."[14] The

[14] Trimble, xiii.

shift from organizational commitment to rigid airships to a rejection of these platforms was very rapid. Althoff summarizes, "In less than a dozen years and for a variety of reasons – technological, military, and political - the airship [fails] to prove its value in naval warfare."[15]

Matthew Evangelista, in his *Innovation and the Arms Race,* points out that students of military affairs rarely make the same distinctions in levels of innovation that are made in the business or economic literature.[16] Economic literature, such as the work by Joseph Schumpeter, for example, distinguishes among invention, innovation, and imitation (or diffusion).[17] The fields of political science and history often fail to make this distinction. As this dissertation is most concerned with the historical aspects of the rigid airship story, an in-depth analysis of varieties and types of innovation is not possible. For the purposes of this dissertation, and in keeping with the general approach adopted by students of military affairs, invention, innovation, and imitation will be combined into the single concept of innovation.

Dissertation Structure

The following chapters trace the development of the rigid airship program in the navy from initial investment to final flights.

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[15] Althoff, *Sky Ships: A History of the Airship in the United States Navy*, xiii.

[16] Matthew Evangelista, *Innovation and the Arms Race: How the United States and the Soviet Union Develop New Military Technologies*, Cornell Studies in Security Affairs (Ithaca: Cornell University Press, 1988), 51-52.

[17] Joseph Alois Schumpeter, *History of Economic Analysis* (New York: Oxford University Press, 1954).

Chapter 2: Approaching Military Innovation

This chapter will discuss current and past theories of military innovation. As the research develops, one or two key theories of innovation will be selected from among major works such as Murray and Millet, Rosen, and Hone. These theories will be discussed in detail, in addition to their relations to the larger business innovation literature. This chapter also addresses the United States Navy in general during the interwar period, providing an over of the national and technological milieu in which airship development took place.

Chapter 3: Deciding on Airships (1913-1921)

The national decision to invest in rigid airships for the navy was made in 1919. This chapter will discuss how this decision was made with an emphasis on the key organizations and individuals involved in the decision. Specifically, the role of the navy General Board, Congress, Joint Airship Board, and Operating navy will be discussed. This chapter is arranged according to these organizational groups rather than chronologically.

Chapter 4: Airship Advocates (1921-1928)

This chapter addresses the period between 1921 and 1928. During this time Mofett and other airship advocates were in the best position to further airship development within the navy. Using a chronological approach, this chapter introduces Moffett, Fulton, and Rosendahl, and discusses their individual contributions to the airship program. Stephen Rosen suggests that, "peacetime military innovation occurs when respected senior military officers formulate a strategy for innovation, which has both intellectual and organizational components."[18] This chapter will examine the strategy that each of these officers developed for pushing the new technology, and how their efforts proceeded between 1921 and 1928.

Chapter 5: Deciding Against the Airship (1926-1938)

Between 1926 and 1938 different groups and individuals solidified their opposition to the navy's airship program. This chapter examines the growth of anti-airship sentiment in this period, culminating with the loss of the navy's last giant airship. The General Board and especially operating navy contributed to the decision to stop investment in the airship. Their perspectives are examined in detail in this chapter.

Chapter 6: Airships and Innovation Theory

Breaking from the chronological approach of the preceding chapters, Chapter six explores the implications of the rigid airship case on innovation literature in the fields of military studies, sociology, and the systems approach. Relevant theories explored in Chapter two are applied specifically to the rigid airship case in order to indicate how and whether this case supports current innovation theory.

Chapter 7: Conclusion: Failed Innovation?

The final chapter of this study summarizes preceding chapters and examines the issue of failed innovation. In this chapter I propose possible components of failed innovation, drawing on the rigid airship history.

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[18] Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military*, Cornell Studies in Security Affairs (Ithaca: Cornell University Press, 1991), 21.

Contribution to the Field

This work contributes to the historical field in two ways. First, through the publication and in-depth research into several archives that are not currently part of the academic literature on airships or innovation. Second, through providing not only data for future innovation studies, but also exploring how the currently-accepted wisdom of key innovation literatures, including military, sociological, and historical theorists such as Murray and Millet and Dr. Rosen can be applied to a case of failed innovation. Can their theories of success help explain failure?

Failed or dead-end technologies are littered throughout the history of warfare, and perhaps especially throughout the history of aviation. Why did this particular technology develop so far before being rejected from within the military context? Was the U.S. Navy of this period improperly organized to make airships successful? If so, why? Was it, as some suggest, the competition from aircraft that drove the airship to its own doom, or was it, as many believe, simply too dangerous? Or did the navy leadership misread the demands of future warfare? Did the organization manage to successfully quell the ambitions of a group of renegades, or mismanage a technology that could have brought significant wartime advantage? This dissertation will seek to narrow and explore the above questions from the perspectives of four naval officers and the organization they served.

Chapter 2: Approaching Military Innovation

This chapter will include a discussion of the general definition of innovation and failed innovation, a brief description of the major writers in the field of military innovation, and an in-depth examination of non-military approaches to the study of innovation.

The objectives of this chapter are threefold:

1. To provide an overview of different approaches to innovation;
2. To introduce technological terms that will be used in future chapters; and
3. To present several specific concepts or theories of innovation that will be applied to the airship case.

These non-military approaches include the works of economists, sociologists, and historians of technology. In each area, traditional dogma will be explored, and some approaches that seem particularly relevant to this study identified.

Innovation and Failure

Many thinkers have tried to define innovation. Some insights may be derived from the definitions presented by different fields of study. In this short section we will examine a few definitions of innovation and how these definitions have shaped the study of the concept.

First, innovation must be distinguished from invention. Invention is most often defined as a portion of the process of innovation. Innovation may encompass activities such as invention, the conception of a new idea, but also development, the shaping of the concept to a market or public, and application, the further refinement of the concept based on inputs and limiting factors. Invention in recent history has come to be seen as the realm of the individual scientist or technologist who combines his view of necessity with available means to create a wholly new item or idea. Innovation is seen more as the work of teams, shaping a raw invention in a market-ready item.

Our focus here is therefore on innovation, rather than invention. The airship advocates that are the focus of this study were not in themselves inventors of a new technology, although they all had the engineering and technical experience to suggest improvements and alterations. Their main role was as 'translators,' helping to facilitate and further the integration of a technology already developed and sanctioned, into the larger navy organization.[1] They were, by definition, innovators.

Definitions shift as we proceed through the approaches of military innovation, economics, sociology, and finally history. The focus of this study is the process of 'translating' new technology into the organization, regardless of the terminology used by a given author or discipline.

The primary question in regard to innovation is its practicality. Most economists argue that invention and innovation cannot be simply novel, but must also necessarily be useful.[2] Legal precedent seems to argue for this as well. A Michigan court declared, "an invention is prima facie an improvement."[3]

Historians' views of innovation are often most concerned with the outcomes of innovation. Philip Scranton, a historian whose work we will examine in further detail, suggests, "Innovation refers to problem-solving at the edges of the known, where solutions

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1 See Thomas P. Hughes, "Emerging Themes in the History of Technology," *Technology and Culture* 20, no. 4 (1979).

2 Jacob Schmookler, *Invention and Economic Growth* (Cambridge: Harvard University Press, 1966), 13.

3 In William Schwarzwaelder and Co. vs. City of Detroit (77F.886,891)

(designs, procedures, practices envisioned) stretch past present capabilities, embrace uncertainty, and generate, after repeated failures, both workable outcomes that are poorly understood and unintended consequences whose implications are inestimable"[4] Historians Chris Freedman and Luc Soete provide a more antagonistic view, defining innovation as, "an essential condition of economic progress and a critical element in the competitive struggle of enterprises and of nation-states."[5]

Perhaps the most important factor of the concept of innovation is its inherent implication of success. Innovation is a term almost exclusively used to define the translation of an idea into an actuality. If this is the definition of innovation, is there a term for innovative efforts that have met with failure? And at what point can failure be declared? Gregory Wilmoth, a historian within the Office of the Chairman of the Joint Chiefs of Staff, suggests that there are three types of innovations, successful, failed, and false-failed. False-failed innovations are initially rejected, but then resurrected to success under different conditions.[6] According to Wilmoth, a false-failed innovation is one that, "is examined and discarded, but that gets another chance under other conditions and succeeds."[7] Wilmoth's definition highlights the importance of context, which is perhaps amplified in the military environment. His definition also indicates the importance of the outcome in considering innovation.

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[4] Philip Scranton, "Technology, Science and American Innovation," 5.

[5] Chris Freeman and Luc Soete, *The Economics of Industrial Innovation*, 3 ed. (Cambridge, Massachusetts: MIT Press, 1997), 2.

[6] Gregory C. Wilmoth, "False-Failed Innovation," *Joint Forces Quarterly*, no. 23 (2000): 51. Interestingly, Wilmoth categorizes the rigid airship as a failed innovation, even as in the first decade of the twenty-first century the Department of Defense begins planning for the acquisition of rigid airships once again.

[7] Wilmoth: 51.

Nearly all authors who have studied innovation have used the criteria of success in choosing their case studies. However, success is not inherent in the traditional definition of innovation. For this study, we will use the broad definition provided by the Oxford English Dictionary: "The action of innovating; the introduction of a new thing; the alteration of something established."[8] Successful innovations are the clear favorite among authors in military literature, economics, sociology, and history.

Because there has been so little work in the field of failed innovation, our approach will be to use predictors of successful innovation as a counter-indicator for failure. That is, by examining how different fields explain successful innovation, we hope to see how to explain failure.

Military Approaches to Innovation

The literature of military innovation is quite limited. The field of military studies in general is somewhat limited, and does not enjoy the input of many closely related fields. Political science makes some contributions, as well as occasionally organizational studies, but the majority of work in the field of military innovation to date has come in the form of historical case studies.

One of the particular challenges facing military innovation literature is the audience. Much of the work in this field is aimed at an audience of modern-day innovators, advocates, or decision-makers, and thus is designed to provide ready-made and digestible insights or prescriptions for success. There has consequently been little development of in-depth academic work in the field of military innovation. For the purposes of this study we will draw on the work of five authors in the field.

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[8] *New Shorter Oxford English Dictionary*, ed.,^eds., 5 ed. (Oxford: Oxford University Press, 2002).

Harold Winton, a professor of Military History at the School of Advanced Airpower Studies in Maxwell, Alabama has contributed a useful methodology through his edited *Challenge of Change*. Winton summarizes the work of several other thinkers when he writes that military change or reform seems to follow certain steps. He describes the following phases of military change:

1- Determine a generally accurate picture of the nature of future war.
2- Determine the operational concepts that will most likely bring victory in this future environment
3- Translate operational concepts into guiding doctrine
4- Test experimental organizations to employ prototype equipment and/or new methods.[9]

Winton's phases demonstrate the importance of a translator, even more so than an inventor, in the process of military innovation. Many factors in the success of an innovation depend not on the technology or process itself, but on external issues, especially the decision maker's ability to accurately assess and respond to the future environment. Winton's approach summarizes the ideas of Stephen Rosen, Williamson Murray and Allen Millet, perhaps the three best-known authors in the field of military innovation.

Stephen Rosen, a professor of national security and military affairs at Harvard, makes his own suggestions on how and why militaries innovate in his *Winning the Next War*. His particular interest is in the differences between peacetime and wartime innovation, although he also addresses technological innovation as a separate question.

Rosen makes several observations regarding military innovation. In particular, he notes that military innovation is different because it occurs in a bureaucratic environment. The nature of military organization itself may be less friendly to innovation than a less

[9] Harold R. Winton and David R. Mets, *The Challenge of Change: Military Institutions and New Realities, 1918-1941*, Studies in War, Society, and the Military (Lincoln: University of Nebraska, 2000), xiii-xiv.

hierarchical system. Rosen rejects the common notion that peacetime innovation is the result of civilian intervention.[10] "Peacetime innovation may be explainable in terms of how military communities evaluate the future character of war, and how they effect change in the senior officer corps."[11]

Rosen suggests that the two major challenges in military technological innovation are the ability to evaluate the enemy, and the ability to evaluate the cost of a given system and compare that cost against reasonable alternatives in an unknowable future operational environment. Rosen concludes that in order to effect successful technological innovation, military organizations must improve their knowledge of the adversary and future war. They must then be able to change the officer corps to respond to this knowledge.

Williamson Murray and Allen Millet, military historians, have written one of the most concise collections of military innovation, *Military Innovation in the Interwar Period*.[12] Their work includes seven case studies of the period between the first and second world wars. They support Rosen's thinking in many ways, emphasizing the role of organizational factors in innovation. Murray and Millett also suggest that innovation can rarely be considered revolutionary, at least in the military. Evolutionary innovation is much more common, and more likely to be successful within the bureaucratic model of the military.

In a summary essay, Murray suggests two factors of successful military innovation and two factors that may indicate failure in military innovation. Successful innovation depends on a specific military problem and a certain military culture. A single, recognized military

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[10] Rosen, *Winning the Next War: Innovation and the Modern Military*, 10.

[11] Rosen, *Winning the Next War: Innovation and the Modern Military*, 52.

problem allows not only the military organization, but the nation and scientific communities to focus their efforts. Military culture, Murray's second factor common to successful innovations, is the sum of the intellectual, professional, and traditional values of the officer corps within a military organization.[13]

The two factors Murray cites as common to failed military innovations are the misuse of history and organizational rigidity. When Murray refers to the misuse of history, his argument is similar to Rosen's. Military organizations innovate poorly when they misapply lessons of history to the future, in essence making an inaccurate prediction of future warfare.

Studies focusing on the United States Navy in the period between the first and second World Wars are limited in number. One of particular interest is Susan J. Douglas' "Technological Innovation and Organizational Change: The Navy's Adoption of Radio, 1899-1919"[14] In this article, Douglas tries to explain why the navy took so long to adopt the radio and integrate it into normal operations. She finds that the main reasons for hesitancy are organizational, rather than technical. She suggests that, "the most critical factor in this twenty-year process of technical adaptation was organizational realignment."[15] Within the organization of the navy at the time, Douglas pinpoints radio advocate in Stanford C. Hooper, a naval officer. He served not only to bring information

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12 Williamson Murray and Allan Reed Millett, *Military Innovation in the Interwar Period* (Cambridge; New York: Cambridge University Press, 1996).

13 Murray and Millett, 313.

14 Susan J. Douglas, "Technological Innovation and Organizational Change: The Navy's Adoption of Radio, 1899-1919," in *Military Enterprise and Technological Change: Perspectives on the American Experience*, ed. Merritt Roe Smith (Cambridge, Massachusetts: MIT Press, 1985).

15 Douglas, "Technological Innovation and Organizational Change: The Navy's Adoption of Radio, 1899-1919," 170.

about the new technology into the organization, but also to promote it. His work was hampered by his inability to push the technology through the rigid organizational structure of the officer corps.

In the same way as Rosen, Douglas finds several lessons about what organizations need to do in order to integrate new technologies. Specifically, management of the technology must be sufficiently high up in the organization to ensure its maximum exploitation. Also, there may need to be a position of relative independence and authority created for a technically and organizationally savvy individual to oversee and evaluate the performance of the new technology. Finally, once the technology is adopted, the organization must participate in and support innovations to it.[16]

Clearly there is a developed field known as military innovation. Why explore beyond this field? Simply put, the non-military discussion of innovation is much more developed. In order to draw on the most modern thought on innovation, and ensure the greatest understanding of the airship failure, we must explore this larger field.

Non-Military Approaches to Innovation

Economists

For most economists studying technology and innovation, the technology itself is exogenous. Jacob Schmookler points out that for some economists this is merely a convenience that facilitates their focus on economic factors. For others, however, the belief that technologies develop outside of economic influences is in fact conviction. Karl Marx, Thorstein Veblen, and Joseph Schumpeter are three classical economists who do not support this isolating view of technology.

[16] Douglas, "Technological Innovation and Organizational Change: The Navy's Adoption of Radio, 1899-1919," 171.

Along a spectrum of product creation, reaching from invention to mass production and distribution, most economists tend to focus on the farthest ends. These issues are perhaps more easily addressed by economic measures than those in the middle of the spectrum. On the far left, economic questions might include: Why do individuals and groups devote resources to creating new things? How does this decision change when variables such as available resources, potential payoff, and perceived relevance shift? On the other end of the spectrum, in the realm of mass production economists ask questions such as: How do individuals and organizations make the production, marketing, and distribution of new goods profitable? Across this entire spectrum, the economic focus is on the search for conditions of success.

In this section we will discuss two major contributors to the field of economic study, Joseph Schumpeter, and Jacob Schmookler. In each case, a short discussion of their contributions to the field will be followed by a more in-depth description of their views of innovation/invention.

Joseph Schumpeter (1883 - 1950) is a classical economist. In terms of his innovation theory, Schumpeter's focus is on the entrepreneur rather than the inventor or engineer. His definition of innovation, discussed in *Business Cycles*[17] is narrowly focused on economic factors. Innovation, according to Schumpeter, is, "the setting up of a new production function. This covers the case of a new commodity, as well as those of a new form of organization such as a merger, of the opening up of new markets, and so on." [18]

[17] Joseph Alois Schumpeter, *Business Cycles; a Theoretical, Historical, and Statistical Analysis of the Capitalist Process*, 1st ed. (New York, London: McGraw-Hill Book Company, inc., 1939).

[18] Schumpeter, *Business Cycles; a Theoretical, Historical, and Statistical Analysis of the Capitalist Process*, 87.

Innovation, growth, and change in consumers' tastes represent for Schumpeter the three factors that drive economic change in society. Innovation, however, is the "outstanding fact in the economic history of capitalist society,"[19] and is, "at the center of practically all the phenomena, difficulties, and problems of economic life in a capitalist society."[20]

Schumpeter, defining innovation as a production process, sees innovations cluster together, both in time and in sector, as organizations in competition adapt to new methods and in turn create their own. Innovation is a factor that both upsets the balance of the economy, or a portion of it, and serves to weed out failing organizations. On the spectrum of invention to mass production, Schumpeter sees innovation occurring late in the process, as it is directly associated with production factors.

Schumpeter's theory of innovation presents a fait accompli, that is, external invention, that in turn helps push innovative entrepreneurs to adopt new internal processes, methods, or technologies to improve their ability to produce efficiently. In this sense his work represents the pure economic view, with innovation – the process of conceiving of a new idea and putting it into practice - as a factor exogenous to the economic process.

Economist Jacob Schmookler (1918 - 1967) is interested in a different part of the innovation 'cycle.' His two major works are *Invention and Economic Growth*[21] and *Patent, Invention, and Economic Change*.[22] Schmookler is interested in addressing how economic growth affects technological innovation. Schmookler distinguishes innovation or

[19] Schumpeter, *Business Cycles; a Theoretical, Historical, and Statistical Analysis of the Capitalist Process*, 86.

[20] Schumpeter, *Business Cycles; a Theoretical, Historical, and Statistical Analysis of the Capitalist Process*, 87.

[21] Schmookler, *Invention and Economic Growth.*

[22] Jacob Schmookler, *Patents, Invention, and Economic Change; Data and Selected Essays* (Cambridge, Mass.: Harvard University Press, 1972).

invention from dissemination. He refers to the *rate of technological progress* as the rate at which new technology is created in a given period, and the *rate of replication* as the rate at which technology is disseminated.[23] Society, Schmookler argues, spends significantly more resources to disseminate technology than to create new technological progress, or innovation. Because they deal with static systems, classical and neo-classical economics are better suited to analyze replication than technological change.

Schmookler's work relies on patent data and is therefore focused not only on individual inventions but also on the legal processes by which they are defined. He explores the motivation and process that inspires an individual or group to invent, rather than the forces that cause an invention to be turned into a consumer product or process. For Schmookler innovation is the adoption of an invention (either a physical item or a process or method) by an enterprise which has never used it before.

His interest in invention and its relationship to economic growth puts Schmookler with economists who focus on the early phases of new technological development, rather than later phases focused on mass production. Schmookler finds that the rate of technological progress is related not only to the extent of the market, but also to economic pressures. He writes that, "major inventions are made normally because particular economic problems have become more pressing or economic opportunities have become more inviting, and not because some scientific finding suddenly pushed them over the horizon."[24] On the whole, Schmookler's inventors create based on traditional economic motivators. Following Schmookler's logic, once an invention becomes "possible," that is, once the materials and

[23] Schmookler, *Invention and Economic Growth*, 2.

knowledge to create it exist and are in the hands of an individual who sees value in the pursuit, it will be created based on purely economic logic.

Schmookler proposes six steps to the occurrence of any invention:

1- The production of the last bit of knowledge to make the invention possible.
2- The acquisition by a potential inventor of the last bit of knowledge he/she needs to create the invention
3- The development of a desire on the part of the inventor or his backer for the effect the invention would produce (ie. wealth, fame, or greater convenience).
4- The decision to try to make the invention.
5- The creation or recognition by the inventor of the root idea of the invention.
6- The reduction of the invention to operable form.[25]

In his more theoretical collection of essays, *Patents, Invention, and Economic Change,* Schmookler goes on to question whether technological change can safely be considered a variable exogenous to economics, and if it currently is one, whether it will remain so. He argues also that, "the key event behind the appearance of a new product therefore may often be not the invention of the product itself but the growth of the potential demand for it."[26]

The economists' views on innovation, especially on the processes of invention and marketing and production are related not only to the development trajectory of the airship in Germany, but also provide insights into the perceived economic relevance of the navy's airships. Schumpeter's work reflects the role of the airship in the navy of the 1920s; the airship already existed as a successful invention, it was up to the airship advocates to innovate and make it a valuable asset to the navy. According to Schmookler, we must examine the level of demand for the new technology as well. Potential demand from the

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[24] Schmookler, *Patents, Invention, and Economic Change; Data and Selected Essays*, 73.

[25] Schmookler, *Invention and Economic Growth*, 16.

[26] Schmookler, *Patents, Invention, and Economic Change; Data and Selected Essays*, 82.

military perspective could be said to include how the new technology can help the organization fight more effectively.

Sociologists/Social Constructivists

The sociological perspective on technological change or innovation is a developing field. Many of its authors are not originally trained sociologists, but are perhaps historians who have taken the social constructivist viewpoint so much to heart that their research can be said to reflect this different perspective. The main concern of sociologists of technology, or those who follow this perspective, is the role of society in technology, and the role of technology in society.

The social constructivists emphasize the role of social factors over others in determining and explaining the direction of technological development. In this section we will discuss three authors who take a sociological perspective on the development of technology, and specifically innovation. In each case, we will summarize only the author's findings that are most relevant to this study.

Wiebe Bijker is a professor of Technology and Society in the School of Arts and Culture, Department of Science, Technology, and Society Studies at the University of Maastricht, the Netherlands. In addition to his own books and articles, Bijker is the editor of the single volume that is perhaps the most useful in considering the social study of technology, *The Social Construction of Technological Systems*. The work is the result of a 1982 workshop of historians and sociologists that came together to rethink social constructivist approaches to the study of technology.

Along the way, according to Bijker, they, "discarded most of the existing approaches to technology advocated by historians, philosophers, and economists."[27] The studies contained in this volume reflect the larger sociological/social constructivist approach, in Bijker's words, "moving away from the individual inventor (or "genius") as the central explanatory concept, from technological determinism, and from making distinctions among technical, social, economic, and political aspects of technological development."[28] Bijker and fifteen other authors contribute to the volume. The volume details what has come to be known as Actor Network Theory (ANT). One sociologist summarizes the ANT approach:

> "If we wish to know how a given technology becomes (or fails to become) a success, we must follow would-be innovators, observing their behaviors and interactions with others. We must do so with no preconceptions as to who those others will be; events themselves reveal which "others" (individuals, groups, natural phenomena) are significant and what interests they have.[29]

Bijker and the other authors in this section have contributed significantly to the development of ANT.

Bijker's work in the compilation volume, as well as his own *Of Bicycles, Bakelites, and Bulbs,* offer a means of graphically portraying the relationship between technologies, social groups, and the problems they share. The example below deals with the Penny-Farthing Bicycle, developed between 1870 and 1878. Bijker uses this example to illustrate social

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[27] Wiebe E. Bijker, Thomas Parke Hughes, and T. J. Pinch, *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, Mass.: MIT Press, 1987), 1.

[28] Bijker, Hughes, and Pinch, 3.

[29] Ann Rudinow Saetnan, "Rigid Politics and Technological Flexibility: The Anatomy of a Failed Hospital Innovation," *Science, Technology, & Human Values* 16, no. 4 (1991): 420.

groups, problems, and technological solutions and how they interact. A social group is a set of people who relate to the technology in a shared manner. Bijker refers to this as their 'technological frame.' Social groups are shown below in the rectangles.[30]

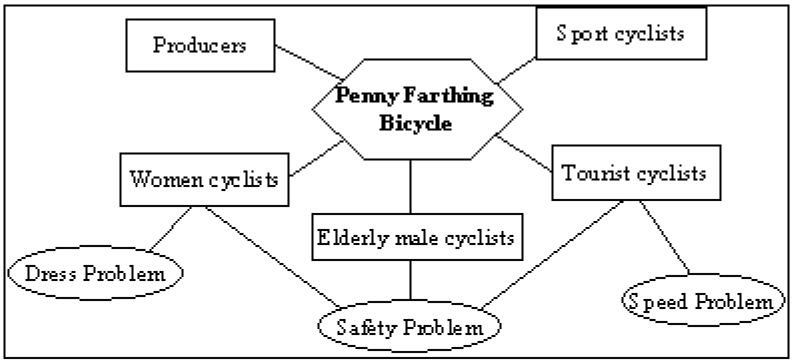

Table 2: Bijker's Technological Frame Concept

Technological frame is composed of concepts and techniques employed by a social group, as well as tacit knowledge, goals, practices, and theories. Through their relationship to a given technology, social groups often have problems which inhibit their interaction with the technology. Women interested in cycling, for example, were faced with the problem of dress, and concerns about safety. In order for a technology to continue developing and draw in and maintain users, it must respond to these problems. In the case of the Penny Farthing bicycle, both the dress and safety problems were addressed through the development of a smaller back wheel structure. In many cases, solutions to these problems result in the creation of new technologies.[31]

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[30] The above schema is adapted from Bijker, Hughes, and Pinch, 35-37.

[31] Bijker argues that solutions to the problems posed by elderly men, women, and sport cyclists led to the development of the Xtraordinary Bicycle and Lawson's Bicyclette. Bijker, Hughes, and Pinch, 34.

Using this schema to examine technological innovation, Bijker suggests three potential developmental situations:

1. No social group is dominant
2. One social group is dominant
3. Two or more social groups striving for dominance

In the first case, if no social group is dominant, innovation will proceed along the lines of the technological frame of the producers. In the second case, a dominant social group will drive innovation to match its technological frame. In the third case, Bijker argues, criteria that are external to both technological frames will play an important role in shaping innovation of the new technology.[32]

Michel Callon and John Law take the social constructivist approach one step further, including technological artifacts and natural phenomena as active elements in a technological network. Their work is considered foundational in the ANT.

Michel Callon, from the Ecole des Mines in Paris sees inventors, engineers, and innovators as part of a network aimed at producing a successful innovation. He suggests, however, that it is impossible to distinguish, "during the process of innovation phases or activities that are distinctly technical or scientific from others that are guided by an economic or commercial logic."[33] In effect, Callon argues that operators and engineers become sociologists in order to assess the social environment in which their technology

[32] From "Simplifying the Complexity" in Wiebe E. Bijker, *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*, Inside Technology (Cambridge, Mass.: MIT Press, 1995), 184.

[33] Michel Callon, "Society in the Making: The Study of Technology as a Tool for Sociological Analysis," in *The Social Construction of Technological Systems*, ed. Thomas P. Hgughes Wiebe E. Bijker, and Trevor J. Pinch (Cambridge: MIT Press, 1987).

will be received. How well they perform at this task is directly related to the success of the innovation.

John Law, a professor of Sociology at Lancaster University, uses the case of Portuguese naval expansion in the sixteenth century to discuss his views of innovation. He argues that the social constructivist viewpoint provided by Bijker is insufficient because it does not take into account the natural environment. Law suggests that the natural environment must be taken into account as part of the explanation of technology development. In particular, Law sees as hostile the environment within which a technology is developed. He introduces the term 'heterogeneous engineer' to describe the individual who draws unhelpful elements into a network to sustain a given technology.[34]

The sociologists/social constructivists provide a unique base for this study. We will use Bijker's approach to mapping out social groups, their relationship to a technology, and problems and solutions, to organize the data surrounding the airship advocates' experience. We will draw on Callon's suggestion that engineers must become successful sociologists to evaluate the advocates. And we will explore Law's integration of the hostile natural environment in describing how the airship fared in the American case.

Historians of Technology

In addition to economists and sociologists, historians have had a hand in defining the study of innovation. Traditionally, these historians have focused on providing thick description of the development path of a given technology. Like economists, successful innovations draw more attention from historians than failures. Historians of technology

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[34] John Law, "Technology and Heterogeneous Engineering: The Case of Portuguese Expansion," in *The Social Construction of Technological Systems*, ed. Thomas P. Hgughes Wiebe E. Bijker, and Trevor J. Pinch (Cambridge: MIT Press, 1987).

also tend to describe events and individuals involved in innovation, with less emphasis on the question of why some innovations are successful.

The history of technology itself is a rather young field. It was officially codified with the creation of the Society for the History of Technology (SHOT) in 1958. Eugene S. Ferguson, a founding member and president of the SHOT, suggests that the history of technology is, “one of the latest threads to be pulled out of the seamless web of history.” He further argues that the field, “has all the appearances of an academic field, yet it is difficult to find in it a discipline or conceptual framework that guides the work being done in its name.”[35]

In recent decades, the history of technology has shifted from narrow instance-and-artifact-centered studies to wider-ranging interests, big structure and large processes. Philip Scranton suggests that this shift is due in part to the desire of historians of technology to be accepted in the general historical literature.[36] Others have argued that the shift to a more integrated view of history reflects recent movements within the larger historical field.

John Staudenmaier, editor of *Technology and Culture*, the quarterly journal of the Society for the History of Technology, has written several articles and one major book using the articles in Technology and Culture to track changes in the history of technology over time. He uses both quantitative and qualitative approaches, tallying articles in specific fields or by type of author to draw inferences about the trajectory of the field.

Staudenmaier classifies historical studies of technology into nine key subject areas, listed below:

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[35] Eugene S. Ferguson, "Toward a Discipline of the History of Technology," *Technology and Culture* 15, no. 1 (1974): 13.

- Technological creativity
- Science-technology relationship
- American system of manufactures
- Electricity
- Military history of technology
- Technology from the capitalist perspective
- Work and gender
- Technological symbolism
- Processes that produce new technologies[37]

Within these nine areas, Staudenmaier distinguishes the first four, which have been a strong part of historical research into technology for decades. The next two, the military and capitalist histories of technology, are areas of renewed interest. Finally, the areas of work and gender, symbolic construction of technology, and the production of new technologies represent the future direction of study for many historians of technology.

Staudenmaier thus traces the study of the history of technology through traditional case-based studies examining internal technological issues to the current, system-based approach to portraying and analyzing historical data on the development of technology. He also highlights a danger cited by both economists and sociologists studying innovation, the

[36] Philip Scranton, "Determinism and Indeterminacy in the History of Technology," *Technology and Culture* 36, no. 2 (1995): 35.

[37] John M. Staudenmaier, "Recent Trends in the History of Technology," *The American Historical Review* 95, no. 3 (1990): 717.

threat of studying only successful cases. In the field of technological history, this problem also can manifest itself in what Staudenmaier calls 'company history.'

Staudenmaier's identification of the shift to more encompassing studies is at the base of one of the major debates in the field of the history of technology, internalist vs. contextualist approaches. Internalists argue that an understanding of the development of a given technology comes only from an initial understanding of the technology itself in minute detail. Contextualists, on the other hand, suggest that the economic, social, political, and scientific context of a technology matters as much as its technical characteristics.

In the section that follows, we will follow Staudenmaier's approach to trace the development of the field of the history of technology, beginning with a short description of case-based studies and working through technological survey studies to finish with an examination of the major thinkers in the field of systems-based historical assessment. At the conclusion of this section, we will address technological symbolism and the ways in which it might relate to the study of the navy's airships.

Case Studies

Most technological case studies deal with non-military technologies. However, there have been several in-depth studies of military-relevant or military-specific technologies. Two that stand out for their historical depth are Merritt Roe Smith's study of the Harpers Ferry Armory,[38] and Donald Mackenzie's recent history of nuclear missile guidance,

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[38] Merritt Roe Smith, *Harpers Ferry Armory and the New Technology: The Challenge of Change* (Ithaca, N.Y.: Cornell University Press, 1977).

Inventing Accuracy.[39] In the field of airship history as well, most historical works are in a traditional case study format. Many of these detailed studies will be integrated into the following chapters as they provide useful detail and historical reference.[40] However, since the case study format is well understood, it will not be further discussed here.

Technological Survey Studies

Hughes in his "Emerging Themes in the History of Technology," argues that surveys of the history of American technology have been generally neglected.[41] When Hughes wrote this article, in 1979, studies of the American manufacturing system were beginning to proliferate, and bridge the gap between historians of technology and generalists as well as economic historians. The majority of these works, however, still have what might be considered limiting faults. A quick look at several survey studies of American technology would be instructive.

The first general field of survey studies is those that focus on a particular time in American technological history, such as Timmons' *Science and Technology in 19th Century America*. Timmons work, like others in this category, separates technologies according to their application, with chapters addressing topics such as transportation, communications, the workplace, the home, and health. This approach can provide useful factual data regarding given technologies. However, it is limited in that any connections existing

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39 Donald A. Mackenzie, *Inventing Accuracy: An Historical Sociology of Nuclear Missile Guidance*, Inside Technology (Cambridge, Mass.: MIT Press, 1990).

40 Several works have been integral to the shaping of this study and provide valuable secondary source information. A few of the key rigid airship case studies I have employed are: Althoff, *Sky Ships: A History of the Airship in the United States Navy*., Thomas S. Hook, *Sky Ship: The Akron Era* (Annapolis, Md.: Airshow, 1976)., Thomas S. Hook, *Flying Hookers for the Macon: The Last Great Rigid Airship Adventure* (Baltimore, MD: Airsho, 2001)., and Robinson and Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935*.

41 Hughes, "Emerging Themes in the History of Technology," 711.

between the social groups of the period are nullified by the separation of technologies into particular fields.

Similarly, works such as Marcus and Segal's *Technology in America: a Brief History*[42] tend to display the history of American technology in terms of technological determinism. As the country 'progresses' "Beyond Mercantilism" technology becomes a force unto itself, acting upon the social environment. One section addresses, "Technology as the Driving Force Behind Modern Life," for example.[43]

Another direction can be seen in the volume edited by Carroll W. Pursell, Jr., *Technology in America: A History of Individuals and Ideas*.[44] This work represents what Staudenmaier refers to as the 'genius' approach to technology. Each chapter is dedicated to an individual, twenty-three in all, whose specific invention changed the face of American technology. There are several obvious shortcomings of this approach, not least of all the implausibility of a single inventor

The increase in studies addressing the American system has continued in the decades following the 1970s. One example of the growing popularity of technology in general works of history, especially dealing with the American system can be found in Philip Scranton's work on the American system, *Endless Novelty,* written in 1997.[45] *Endless Novelty* reflects the main tenets of histories of technology in that it presents technological

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[42] Alan I. Marcus and Howard P. Segal, *Technology in America: A Brief History*, 2nd ed. (Fort Worth: Harcourt Brace College Publishers, 1999).

[43] Marcus and Segal, *Technology in America: A Brief History*, 316.

[44] Carroll W. Pursell, *Technology in America: A History of Individuals and Ideas* (Cambridge, Mass.: MIT Press, 1981).

[45] Philip Scranton is a professor of industry and technology at Rutgers University.

information in a format understandable to the layman, provides thick description in a few specific areas, and focuses on narrative rather than analytical approaches.

Scranton's more recent works deal with the issue of innovation. In his "Technology, Science, and American Innovation," he argues for a 'reframing of historical perspectives on innovation.'[46] For this study, two concepts described by Scranton are relevant, first, that in the period of American industrial growth (1890-1970) innovation was just as important as the development and refinement of mass production. Scranton suggests that the creators of the mass production world, such as Henry Ford, have been given too much credit for the economic success of that period. Second, Scranton argues that while the period after World War II can be characterized as one in which the national security state defined the critical issues for innovation; in the late nineteenth and early twentieth century, it was market pressures that drove innovation. While Scranton's larger interest is in this later period, following World War II, his suggestion gives weight to the argument that business approaches are relevant to the study of innovation in the period of airship development.

Systems-Studies

A subset of technological historians is the systems theorists. The basic concept behind the systems theory is to use deep description to include social, economic, legislative, and other factors in the consideration of technological development. Much like the sociologists, this group of historians would like to see traditionally external factors drawn into the explanation of how technology shapes and is shaped by society. While several authors are writing using this approach, the central figure is Thomas Hughes, a professor in

MIT's Science, Technology, and Society Program. Other authors, such as Philip Scranton, and Louis Galambos apply the systems approach to specific case studies. We will examine the development of the systems approach application and how it has been applied to the history of technology through each of these authors.

Thomas Hughes' work in the field of technological history reflects the transition that the field has undergone in the past several decades. His early work is emblematic of the more traditional history of technology approaches, focusing on case studies and to a certain degree isolating technology from its social context. With *Network of Power*, written in 1983, Hughes laid out the basis of what would become known as the systems method for technological histories.

Historians of various genres have used the concept of a systems approach for centuries. The basic approach, according to Hughes, allows the historian to "organize, analyze, and draw conclusions from disparate materials."[47] Perhaps the first author to describe the systems approach was Ludwig von Bertalanffy, a theoretical biologist. Bertalanffy's concept posited the system as a collection of interrelated components which show structural similarities. His objective was to deduce universal principles that are valid for systems in general. While this is a scientific approach, there are many historians who have used it, especially to apply to international systems, such as economics in Karl Marx's *Capital: A Critique of Political Economy*, and the geographical/meteorological

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[46] Scranton, "Technology, Science and American Innovation," 2.

[47] Thomas Parke Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: Johns Hopkins University Press, 1983), 7.

environment in Fernand Braudel's *The Mediterranean and the Mediterranean World in the Age of Philip II.*

In the history of technology, the systems approach integrates social, legal, and other factors in understanding the development of a technological system. The technological artifact is seen in its essence as a system itself, that is, it is not freestanding, either from its environment or from other technologies. Technology, in Hughes' perspective, is inherently networked into systems that include physical artifacts, organizations, and natural resources, all of which are created by a 'system builder.' The system builder has some facets in common with Law's heterogeneous engineers; they are not engineers or inventors per se, but serve to draw together, create, and control artifacts as well as incorporating and reshaping the environment to better accept and supply the technological system.[48]

Many scholars consider *Network of Power*, to be the best modern example of the systems approach applied to the history of technology. Hughes' work details how electrical power networks in Berlin, Chicago, and London are both socially constructed and society-shaping.[49] Hughes' objective is not only to provide a thick description of the development of electrical power networks in several social environments, but also to translate the systems method into a technological context so that other historians can draw on his work.

To that end, Hughes summarizes the phases of technology development in the systems approach as follows:

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[48] Hughes makes the comparison between systems builders and heterogeneous engineers in Thomas P. Hughes, "Evolution of Large Technological Systems," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Thomas P. Hgughes Wiebe E. Bijker, and Trevor J. Pinch (Cambridge: MIT Press, 1987), 51.

[49] Hughes, "Evolution of Large Technological Systems," 52.

Phase 1: Invention and development of the system is considered. The work in this phase is led and conducted by inventors and entrepreneurs. In the electrical network study, this role was played by Edison and his compatriots.

Phase 2: Transfer of technology from one society or region to another. Systems builders begin to shape how the transfer is effected, resulting in differing technological styles based on region, artifacts of the system, and environment. For the electrical networks, know-how and physical technology were transferred, copied, and refashioned from America into other regions.

Phase 3: System growth. The system expands, taking more elements of the environment into the system's control, turning them into de facto artifacts. Hughes introduces the term 'reverse salients' to refer to the uneven growth of the system. Reverse salients are components in the system that have fallen behind or are out of phase with the others. Hughes suggests that where reverse salients are found, communities of inventors also congregate, aiming to solve problems. In the electrical example, expansion was physical as well as social. The network itself grew in terms of physical space covered, and organizations involved while its consuming public increased demand as electrical products became more available.

Phase 4: Momentum. The system sustains a given level of mass, velocity, and direction. As Hughes explains, "in the case of technological systems… the mass consists of machines, devices, structures, and other physical artifacts in which considerable capital has been invested."[50] A system often increases in velocity, or growth rate, as it expands. Direction can be seen as goals, which are solidified as the system achieves momentum.

In the last three phases of the systems model, it is the system managers, rather than the inventors, who have the most influence on shaping the development of the system. It is on these three phases that this study will focus. For the story of rigid airships in the U.S. Navy, the story of greatest interest also occurs in these last three phases. Invention, and most technical improvements to the system had already occurred long before in Germany, for the airship advocates, their story begins with the transfer of technology, and may end even before momentum is achieved.

Hughes' systems manager is key to the technological system, not only in ensuring its existence, but also through intentional and unintentional social "printing" by which his/her decisions socially shape the system. The effective systems manager has to translate between the technology and the outside environment, all the while drawing more of the environment into the control and purview of the system. This is achieved, Hughes argues, through the successful simultaneous management of technological, economic, and political matters. In the electrical network, this meant engineering the design of a lamp filament, the price competition with existing gas suppliers, and the legislative frameworks within which the electrical market developed.

From the historians we will use Staudenmaier's study highlighting the importance of thick description, analytical application, and Hughes' framework of systems-based study. We will also apply Hughes' terminology of technological style, reverse salients, and

[50] Hughes, *Networks of Power: Electrification in Western Society, 1880-1930*, 15.

momentum to help explain why the rigid airship took its particular path through the navy in the 1920s.

Failed Innovation Studies and Theories

Staudenmaier's study of *Technology and Culture*, the journal of the Society for the History of Technology (SHOT) found that between 1959 and 1980, only 21 out of 272 articles dealt with specifics of failed technological innovations. Of these, twelve were studies of 'pauses' in the trajectories of otherwise successful innovations. Three dealt with other issues associated with failure studies, such as the role of feminine modalities in technological language. With only six remaining, Staudenmaier makes clear the lack of focus on failed innovations. He further suggests that, "it can be argued that these articles are both too few and too isolated from one another to constitute a significant contribution to the integration of design and ambience. None of them gives evidence of being part of a thematic community of discourse."[51]

Despite the lack of particular field of failed innovation studies, there are a few studies of failed innovation that provide some useful insight for this study. The Society for the Social Studies of Science, a Louisiana-based organization, "devoted to understanding science and technology.[52] The organization held a symposium in 1992 on failed innovations which was the substance of an entire issue of its journal, *Social Studies of*

[51] John M. Staudenmaier, *Technology's Storytellers: Reweaving the Human Fabric* (Cambridge, Mass.: Society for the History of Technology and the MIT Press, 1985), 176.

[52] The Society draws in scholars from fields such as sociology, anthropology, history, philosophy, political science, economics, and psychology and also publishes *Technoscience* and the *Handbook of Science and Technology Studies.* http://www.4sonline.org/society.htm

Science.[53] We will look at one study from this issue, by R.A. Buchanan, Director of the Center for the History of Technology at the University of Bath, in some detail.

R.A. Buchanan's study addresses the proposed atmospheric railway designed for South Devon in 1844.[54] Buchanan describes the development of the concept, through testing phases. He finds that the technology broke down for two major reasons. First, the technology had difficulty being scaled up from early test models. Second, throughout the atmospheric railway's development, it faced improvements in competing technologies, steam locomotion and electric traction. Eventually, as technical issues slowed the development of the atmospheric railway, competing technologies overtook it.

Ann Rudinow Saetnan, of the University of Trondheim, also found non-technical reasons for the failure of a technology.[55] The PREOP, a production planning system for surgeries, was introduced in a Lillehamer hospital but later rejected. Saetnan used the Actor Network Theory as well as Labor theory to examine why the PREOP was not adopted despite its apparent technical aptitude. Saetnan finds that PREOP failed in large part because the various social groups interacting with it had differing demands. PREOP seemed to fulfill the demands of nurses, patients, doctors, and hospital administration, but in the end was unable to bridge the wide variety of these demands. There was also no individual or group designated to reshape PREOP to fit user demands.

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[53] The failed innovation symposium was written up in the May 1992 issue of *Social Studies of Science*, one of the Society for the Social Studies of Science's several journals. This issue included multiple in-depth studies of failed innovations ranging from technologies that were not adopted such as the automobile gas turbine engine and the plastic bicycle to failed approaches to airmail pickup and industrialized house construction.

[54] R.A. Buchanan, "The Atmospheric Railway of I.K. Brunel," *Social Studies of Science* 22, no. 2 (1992).

[55] Saetnan, "Rigid Politics and Technological Flexibility: The Anatomy of a Failed Hospital Innovation."

Another study examining failed innovation is sociologist Bruno Latour's *Aramis, or the Love of Technology*. The book is a semi-detective novel study that poses Aramis, a new French transportation system, as the victim in an unintended homicide. The French public, French train system, and even the author as the investigating sociologist play a role in the complex drama designed to explain why Aramis died. He concludes that the demise of the Aramis system was the result of insufficient interaction with and adaptation to the social groups that would be using the transportation system. As a means of shorthand, Latour claims Aramis died because it wasn't loved.[56]

This terminology may be misleading; his argument was in fact that Aramis as a network or system was never made real for the social groups that would use it. Using the terminology of the sociologists and historians, we can say that Latour argues that the Aramis' systems builders or heterogeneous engineers were never able to draw hostile actors into supporting the technology.

Failed innovation studies suggest some areas of focus for this work. Buchanan, Saetnan, and Latour all point to the role of culture in innovation. Organizations, and even national identities seem to play a role in whether and how technologies are adopted and adapted.

Conclusion

In this study we will try to combine the historical and sociological perspectives on innovation. The systems and sociological approaches described by Wiebe, Bijker and Hughes will provide a base and shaping mechanism for this study.

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[56] Bruno Latour, *Aramis, or, the Love of Technology* (Cambridge, Mass.: Harvard University Press, 1996).

Chapter Three will examine the strategic and operational environment that faced the advocates of the airship. We will draw on the approaches of Rosen and Murray and Millett to highlight relevant information regarding the American perception of its enemies and future war in that time period.

Chapter Four will provide a thick description case study of the five naval officers involved in the navy's rigid airship program.

Chapter Five will be more analytically structured, aiming to assess and examine the larger questions of innovation in a social context. We will use Bijker's concept of social groups, to try to examine whether the airship advocates acted as a distinct social group. Also from Bijker's work, this chapter will attempt to recast and better understand the historical events of this period in terms of social groups, problem sets, and solutions.

Chapter Five will also draw on Hughes' concept of systems managers. We will see how the advocates, if at all, behaved as systems managers. How did they relate with and manage the larger context of the legislative, economic, etc. factors in arguing for the airship? Does Hughes' explanation of reverse salients shed any light on the rigid airship as a failed innovation? Additionally, we will explore the role of the airship as a technological symbol.

In Chapter Six we will explore the world of the airshipmen in relation to the navy. We will examine the career path of enlisted men and officers of the airship program and their perceived role in combat.

This combination of traditional historical study and analytical assessment should help answer the demand for in-depth association between technical change and the environment.

It will explore Scranton's assertion that, "Links between technical change and sociopolitical relations are intimate and underspecified."[57]

The concluding chapter will address the airship as a failed innovation. We will use the thick description and analytic approaches of chapters three through six to apply the perspectives on failed innovation discussed in this chapter to the airship case.

[57] Scranton, "Determinism and Indeterminacy in the History of Technology," 48.

Chapter 3: Deciding on Airships (1913-1921)

Rigid Airships in the American Naval Environment

The first major government study recommending the acquisition of an American rigid airship was completed in 1913. In the period leading up to this study the United States Navy was mainly focused on newer and better methods of traditional war at sea, rather than revolutionary aviation technologies. The navy drew its inspiration and focus in this period from the British Royal Navy. After three centuries of nearly unparalleled success, the Royal Navy stood as the standard for all major fleets of the world, and even more so for the American Navy, its junior partner in the Pax Britannica. Alfred Thayer Mahan, one of the U.S. Navy's greatest thinkers, wrote in 1894, "Naval officers of the United States should feel a peculiar sympathy with Englishmen, over and above which is felt by the mass of our fellow citizens, because by our education and our habits of thought we are brought in close sympathy and contact with the greatest of all British interests, the British Navy."[1]

At this time, the United States Naval Academy at Annapolis Maryland provided the sole route to becoming an officer of the line, a commission required to command the navy's battleships.[2] Battleships held a place of primacy in naval orders of battle around the world. The first American dreadnought, a battleship equipped with an unprecedented number of heavy guns, was commissioned in 1910. Like her predecessor, the 1906 British

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[1] Robert L. O'Connell, *Sacred Vessels: The Cult of the Battleship and the Rise of the U.S. Navy* (New York: Oxford University Press, 1993), 15.

[2] The role of the Academy as sole source of commissioning for officers of the line would hold true until 1925. Kenneth J. Hagan, *In Peace and War: Interpretations of American Naval History, 1775-1984*, 2nd ed., Contributions in Military History, No. 41 (Westport, Conn.: Greenwood Press, 1984), 86-87.

Dreadnought, the new American ship with her armaments made every earlier battleship obsolete. Between 1910 and 1913 eight American dreadnoughts were commissioned, increasing in size from 16,000 tons to 26,000 tons displacement.[3] Rarely has such an industrial accomplishment been achieved.

While it seemed that future naval warfare was to be fought between large, heavily armed surface ships, the first decade of the twentieth century also implied a different future. By 1910 navy leadership had acknowledged an interested in aviation that quickly developed into investment and training plans. In October of 1910 the Secretary of the Navy approved a recommendation to assign two officers to examine and report on the progress of aviation.[4] By May of the next year plans were completed for the first two naval aircraft, and the navy's new flight training program had produced its first graduate. Airplanes were being launched, and sometimes recovered, from a specially-altered surface ship. These were of course small events when compared to the centrality of the officers and sailors employed in supporting the battleship navy. It would be several decades before the naval air arm could challenge the primacy of the navy's battleship base.

Initially the leadership of the operating navy, staffed mainly by battleship officers, had limited interest in the airship. The German Navy employed rigid airships in World War I with seemingly inconclusive results.[5] While the operating navy explored with airplanes, the navy's General Board and the Naval Affairs Committee in Congress were the

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[3] Paul H. Silverstone, *The New Navy, 1883-1922*, The U.S. Navy Warship Series (New York: Routledge, 2006), 12-13.

[4] Jack Sweetman, *American Naval History: An Illustrated Chronology of the U.S. Navy and Marine Corps, 1775-Present*, 3rd ed. (Annapolis, Md.: Naval Institute Press, 2002), 124.

[5] Many naval officers referred to the role of the airship in the Battle of Jutland, but most historians find the contribution of the airships to be negligible at best.

main leaders behind the push for acquisition of the airship. These two organizations, more than others, were able to directly influence funding and were central to the initial airship investment decisions. These groups built their understanding of current capabilities and future expectations for the airship on their views of airship performance during World War I. The acquisition plan resulting from their advocacy was a multi-phased compromise that would have a dramatic effect on how large rigid airships were used and eventually rejected by the navy.

This chapter is divided into two portions. The first will address the navy General Board and Congress. The General Board helped direct and shape naval strategic thought from 1900 to 1932.[6] Its views on the rigid airship underpin the initial investment decision. Congress, while providing similar strategic leadership, also supported and encouraged the decision to invest in airships through direct funding. We will examine each of these key organizations in detail, their views on the potential of the rigid airships and their effect on initial acquisition. In addition to the General Board and Congress, two other groups had an important hand in deciding on airships, the Joint Army and Navy Airship Board and the operating navy. A short discussion of their roles is also included in this chapter.

Between 1913 and 1921 long-term planners ensured that the navy would acquire three rigid airships. The airship advocates that are the subject of this study did not play a significant role in the initial airship acquisitions. The navy, in the words of Moffett's

[6] The General Board existed until the mid-1940s, but its importance in policy decisions declined greatly with the removal of the Chief of Naval Operations as a part-time member in 1932. See Robert Greenhalgh Albion and Rowena Reed, *Makers of Naval Policy, 1798-1947* (Annapolis, MD.: Naval Institute Press, 1980), 92-93.

biographer, had, "already made a considerable commitment to the airship before he [Moffett] became bureau chief."[7]

The Navy General Board and the United States Congress were the central organizations in this early commitment to invest in airships. Their recommendations, reports, and policies overlap in time, but to examine each organization's distinct contributions and effects we will deal with them separately. Following a discussion of the General Board and Congress, two organizations with lesser, but relevant input into the initial investment decision will be discussed.

Navy General Board

Between 1842 and 1966 the administration of the navy was based on a bureau system.[8] The navy's bureaus, in the words of historian Edward S. Miller, "managed [the navy's] affairs directly under the civilian secretary [and] guarded their turf jealously with the aid of congressional friends."[9] The bureaus, run by chiefs designated and empowered by the Secretary, dealt with all issues of importance to the daily operation of the navy.[10] The bureau system, however, left major strategic planning in the hands of an often-inexperienced civilian Navy Secretary.[11]

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7 Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 125.

8 For information on the Navy's Bureau System, see Henry P. Beers, "The Development of the Office of the Chief of Naval Operations," *Military Affairs: Journal of the American Military Institute* 11, no. 4 (1947): 42-45.

9 Edward S. Miller, *War Plan Orange: The U.S. Strategy to Defeat Japan, 1897-1945* (Annapolis, Md.: Naval Institute Press, 1991), 14.

10 By 1916 eight bureaus existed for yards and docks; construction; equipment, and repair; provisions and clothing; ordnance and hydrography; medicine and surgery; navigation; steam engineering; and equipment. For further information on the bureau system and Navy Department management, see Robert W. Neeser, "The Department of the Navy," *The American Political Science Review* 11, no. 1 (1917).

11 The bureaus, according to Paolo E. Coletta, "enjoyed equality of representation within the Department… Bureau chiefs were to provide support to the fleet, not to offer the secretary collective advice on the military functions of the Navy. Each operated independently…" Paolo Enrico Coletta, *A Survey of U.S. Naval Affairs, 1865-1917* (Lanham, MD: University Press of America, 1987), 11.

Prior to the creation of the General Board in 1900, the Secretary of the Navy conducted strategic planning based on the advice of ad hoc gatherings of senior officers called into advisory panels.[12] Shifting interests and individuals in these ad hoc formations resulted in a lack of consistency.[13] The creation of the General Board alleviated some of these difficulties and provided the Secretary with war plans, measures to prepare the fleet for war, requirements for warships, and advice regarding shore stations.[14] Historian Robert Greenhalgh Albion suggests that the creation of the General Board gave the navy, for the first time, a group of dedicated, highly qualified senior officers to consider the navy's needs.[15] The combination of focus on strategic issues and permanence of the organization made the navy's General Board a very effective strategic planning organization.

Members of the Board were almost always senior naval officers, chosen and appointed for limited periods during their naval careers. Some, such as Admiral George Dewey served for several decades. Both Dewey and Taylor were members of the full-time portion of the board, known as the Executive Committee. The Executive Committee included four to six members and was supplemented as necessary by ex-officio members.

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12 One of the most significant of these temporary boards, and a precursor to the General Board, was the 1898 Strategy Board. The General Board was described and detailed by CAPT Henry C. Taylor in Henry C. Taylor, "Memorandum on a General Staff for the Us Navy," *United States Naval Institute Proceedings* XXVI (1890).

13 For further discussion of the pre-General Board environment in the Navy, see Albion and Reed, *Makers of Naval Policy, 1798-1947*, 79.

14 United States. Navy Dept., *Regulations for the Government of the Navy of the United States. 1905* (Washington: Govt. Print. Off., 1905), 19. CAPT Henry C. Taylor, directly involved in the creation of the General Board, indicated that the Board was to draw together what were already the roots of a general staff system found in the Naval War College and Office of Naval Intelligence. See Neeser: 64-67. Beers, "The Development of the Office of the Chief of Naval Operations."

15 Albion and Reed, *Makers of Naval Policy, 1798-1947*, 79.

The most important among these ex-officio members was an active duty naval officer who provided a direct link to the operating navy.[16] This man made a tangible connection between the policy-makers and strategy-writers of the General Board and the operating navy that would enact these policies and strategies. The Board described its own role in a 1926 memo to the Secretary of the Navy,

> As regards the General Board of the Navy, this Board is purely an advisory board to the Secretary of the Navy. The General Board is not created by legislative action and has no administrative functions and no executive power whatsoever. There are no bureau representatives as such on the Board, and the Board strongly recommends that no legislation be enacted prescribing any membership on the General Board, and that the Board remain as it is at present, appointed by and answerable to the Secretary of the Navy only in an advisory capacity. In all important matters of policy, the Bureaus concerned are called into conference, and full and free discussions are held before any recommendations are made. To appoint members to the General Board with a view to representing the particular interests of any one element of the national defense will tend to defeat the object and usefulness of the General Board.[17]

Even though they were senior officers serving exclusively in an advisory purpose, the larger navy could not ignore the General Board and its members. Not only did the Board have the ear of the Secretary and often Congress, but also a good number of members of the Board went on to high positions within the navy. Two of particular note are Admiral Frederick J. Horne, who went from the Board to be the Vice Chief of Naval Operations, and Admiral Ernest J. King, who became Commander in Chief of the United States Fleet and then Chief of Naval Operations.

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[16] The position of this active duty officer shifted over the life of the General Board, initially the seat was held by the Chief of the Bureau of Navigation, and passed through the Aide for Operations before remaining for several decades with the Chief of Naval Operations. Albion and Reed, *Makers of Naval Policy, 1798-1947*, 80.

[17] General Board, "Report of Board to Consider and Recommend Upon Present Aeronautic Policy," (Serial 449 Box 191; Records of the General Board; Record Group 80; National Archives Building, Washington, DC.: 1927), 9.

The General Board's main audience and client was the Secretary of the Navy. He referred specific issues to the Board, as well as requests for broader consideration. The General Board dealt with issues including internal policy, ship design, and strategic planning. In some cases, the General Board would meet and deliberate for several hours on a letter that had been addressed to the Secretary and then forwarded to the Board for consideration.[18] In other cases, the Board held extensive hearings, drawing in officers of the navy and other services as well as American and foreign civilian experts to consider an issue of the Secretary's interest.[19] Often these efforts would result in specific recommendations to the Secretary, or, in the case of broader issues, statements of general policy. During the period of airship development, the Secretary's acceptance of General Board recommendations was so ingrained that the Secretary had only to sign a pre-formatted form letter indicating his acceptance of a given Board recommendation.[20]

The Airship and Strategic Planning

With its focus on strategic planning and warship design, the General Board's view of the rigid airship focused on its basic capabilities and how they could be applied to the strategic and operational challenges faced by the United States Navy. Even before the United States entered World War I, senior naval officers were preparing for potential operations. The navy highlighted patrol and convoy work before and in the early phases of

[18] One such example of this quick-turnaround advisory can be seen in a 1918 letter from the Joint Army and Navy Airship Board. The letter was sent to the Secretary of the Navy on 17 July, forwarded to the General Board "for consideration and recommendation" on 1 August, and returned to the Secretary with the Board's comments and specific recommendations on 21 August. General Board, "Subject: Rigid Airships. Recommendations of Joint Army and Navy Airship Board," (Serial 449 Box 189; Records of the General Board; Record Group 80; National Archives Building, Washington, DC.: 1918).

[19] The complete hearings of the General Board can be found at the Library of Congress.

[20] One example of these 'form letters' can be seen in 2nd endorsement GB No 449 Serial 615 October 19, 1916. Subject: Policy with Regard to Development of Zeppelins.

the First World War as areas in which the navy could be particularly useful to American allies. Airship advocate Garland Fulton, writing one of his several histories of the period, adds that, "anything that had to do with combating the submarine menace automatically commanded the highest priorities."[21]

In the eyes of the General Board, and others, the employment of the airship during World War I seemed to justify investment for the United States Navy. Richard K. Smith, an airship historian, suggests that three important factors in rigid airship performance made them particularly attractive for naval warfare, the rigid airship provided:

1) Three times the speed of the fastest surface vessels;
2) Several times the load-carrying ability of the largest airplanes built during the interwar years; and
3) In the 1920s at least ten times the out-and-back range of military airplanes.[22]

These three capabilities combined to make a platform that seemed ideal for long-distance operations requiring extended presence. Beyond the General Board, several other sources in the early stages of the war identified the rigid airship's inherent value in these types of operations. An August 1919 report from the U.S. Naval Experimentation Station in New London discusses the use of airships as anti-submarine platforms by the British navy, and highlights the ships' mobility, ability to rise and descend to the surface quickly, and maintain location over the water without landing.[23]

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[21] Garland Fulton, "Recollections of the Early History of Naval Aviation," *Naval Engineers Journal* (1964): 749.

[22] Richard K. Smith, *The Airships Akron and Macon: Flying Aircraft Carriers of the United States Navy* (Annapolis, MD: United States Naval Institute, 1965), xxi.

[23] Naval Experimental Station, "Hunt of a German Submarines by Dirigible and Chase," (Folder 2, Box 19, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1918), 1.

For the General Board, the airship's wartime performance appeared to validate the Board's view of airship use. In a 1913 report, the Board observed, "the events of the war so far [the United States had not yet entered the war] have confirmed the General Board in the conclusions reached. . . As to the immediate development of the rigid dirigibles as a necessary arm of the fleet for Naval reconnaissance, the escort of convoys, scouting for raiders and submarines outside the range of small semi-rigid dirigibles, and for general scouting work with the fleet."[24] The mere presence of an airship appeared to suppress enemy activities. In fact, contemporaries and historians pointed out that no convoy under airship protection was ever attacked.[25] Harry Vissering, an author of the day, wrote a work entitled *Zeppelin: the Story of a Great Achievement* that explored the role of airships in the German war operations.[26] By his depiction the German airships,

> Cruised over the North Sea, scouting and guarding the coastline, remaining in the air for 30 hours at a time. They flew out from the western outlet of the Kiel Canal, northward along the shores of Denmark to the Norwegian coast, and thus were able to command the sea for hundreds of miles around with powerful glasses [binoculars]. They had constantly hampered the enemy's mine laying operations and rendered timely and valuable support to the counteractions of the Fleet. In discovering mines they were particularly effective; and this work alone, about which the world was uninformed, justified fully the time and labor put into their construction.[27]

It was logical then that in order to assess the airship's value in the war, the General Board looked to the experience of the Germans. By 1913 German warplans included their rigid airships in defensive and some attack roles. During major naval battles of 1914 and 1915, the Zeppelins would prove their value. According to one historian, the Zeppelins,

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24 General Board, "Subject: Rigid Airships. Recommendations of Joint Army and Navy Airship Board," 3.

25 "The Uses of Airships for the Navy," (Folder 2, Box 19, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1917), 2.

26 Harry Vissering, *Zeppelin; the Story of a Great Achievement* ([Chicago: Printed by Wells and company, 1922).

"saved the High Sea Fleet at the Battle of Jutland, saved their cruiser squadron on the Yarmouth raid, and have been instrumental in sinking the *Nottingham* and *Falmouth*."[28] The British Navy, embarked on its own acquisition plan, had a favorable view of the airship as well. Admiral Jellicoe, who led the British Navy at the Battle of Jutland, declared, "The German Zeppelins as their numbers increased were of great assistance to the enemy for scouting, each one being, in favorable weather, equal to at least two light cruisers for such purpose."[29]

Admiral Reinhard Scheer, who assumed command of the German High Seas Fleet in 1916, published his memoirs of the war at sea in 1920.[30] He noted that,

> The value of airships as a weapon has been much called into question. In the beginning of the war, when seaplane-flying was quite undeveloped, they were indispensable to us. Their wide field of vision, their high speed, and their great reliability when compared with the possibilities of scouting by war-ships, enabled the airships to lend us the greatest assistance. But only in fine weather. So the Fleet had to make its activities dependent on those of the airships, or do without them.[31]

In addition to its apparent usefulness in World War I, the airship seemed to have capabilities that were consistent with the navy's strategic war plans. War Plan Orange, which detailed campaigns against Japan, focused on island-seizing, defending, and maintaining, causing a different approach to air warfare than was demanded in the first

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27 Vissering, *Zeppelin; the Story of a Great Achievement*, 120.

28 "The Uses of Airships for the Navy," 5.

29 John Rushworth Jellicoe Jellicoe, *The Grand Fleet; 1914-16; Its Creation, Development and Work* (London, New York [etc.]: Cassell and company, ltd., 1919). Cited in Garland Fulton, "Vulnerability of Airships in World War I," (Folder 3, Box 16, George Henry Mills Collection (Acc. 1994-0022). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1936), 1.

30 Reinhard Scheer, *Germany's High Sea Fleet in the World War* (London, New York [etc.]: Cassell and Company, ltd., 1920).

World War.[32] In particular, the navy's strategic planners thought that safely moving the battle fleet across the Pacific would require a large number of expensive scouting cruisers. However, it seemed unlikely that Congress would appropriate the level of required funding to acquire and maintain them. The rigid airship, with its long range, heavy lift ability, and superior scouting seemed to be a platform designed for the Pacific theater.[33]

While the airship's wartime experience and warplan promise created sufficient argument for investment, the General Board also based some of its push for acquisition on expectations of the future capabilities of the airship. Scientists and naval officers studying the question predicted great increases in lift capacity, endurance, and speed. Lift was expected to grow by an order of magnitude between 1918 and 1920. The airship of 1920 was also projected to provide a speed of 40-45 miles per hour for up to three weeks, with occasional bursts of 75 miles per hour as needed.[34] These projected capabilities were found not only in official reports, but also in journals and popular magazines and newspapers. The navy's first airships would be faced with fulfilling these promised capabilities.

General Board Recommendations/Reports

The General Board made its first specific input to the question of airships in 1913. The Navy Aide for Operations, through the Secretary of the Navy, requested a summary of

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31 When David Ingalls, American Assistant Secretary of War, cited this passage in his 1932 paper, he left out Scheer's note that the airships were particularly useful "when seaplane-flying was quite undeveloped." Ingalls, an airship supporter, had correctly identified the threat from a competing technology. Scheer, *Germany's High Sea Fleet in the World War*, Chapter 12.

32 War Plan Orange, one of the Rainbow Plans, was signed formally by the Secretaries of War and the Navy in 1924, but had been endorsed by senior planning officers for several years prior. For further information, see Gerald E. Wheeler, *Prelude to Pearl Harbor; the United States Navy and the Far East, 1921-1931* (Columbia: University of Missouri Press, 1963), 83. and Miller, *War Plan Orange: The U.S. Strategy to Defeat Japan, 1897-1945.*

33 For a discussion of the airship's potential to fulfill requirements in the Pacific, see Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 13-14.

34 W. Lockwood Hareh, "The Case for the Airship; Extract from Aeronautics Magazine," (Entry #160 Box 19; Record Group 72; National Archives Building, Washington, DC.: 1918), 2.

what nations in Europe were doing to prepare for aerial warfare, including an assessment of their development of airships and airplanes.[35] The query instigated General Board discussions, which led to the first General Board report on airships. The report, issued in August 1913, indicated not only an assessment of European aerial warfare capabilities, but also included specific recommendations for the Secretary in regards to developing aerial warfare capability within the U.S. Navy.

The 1913 report includes information on lighter-than-air and heavier-than-air development in England, France, Germany, Italy, and the United States. The numbers of aircraft possessed by each country indicate the comparatively underdeveloped state of military aviation in the United States at the time. France was seen as the leader in heavier-than-air aviation, and Germany as the lead in lighter-than-air. Germany's airships were noted to have speeds of 45.7 knots per hour, and carry fuel for 30 hours of flight. Their airships were armed with, "2-1 pounders and 4 maxims, and wireless outfit for 300 miles." At the time Germany had seven airships on hand, were building four and had two more on order. Thirteen mine laying and scouting non-rigid airships were also included in the German arsenal.[36]

In addition to reporting on numbers of aircraft, the Board's report addressed organizational issues, noting that, while the U.S. Army had more aerial capability than the American Navy, there was no plan for cooperation between the services whatsoever. The Board noted that, "in the navy aviation appears to be in an even more embryonic and

[35] The Aid for Operations was one of four Aids designated to the Secretary of the Navy. His responsibility was to advise the Secretary, in conjunction with the General Board, on matters of strategic and tactical importance, and on the positioning of naval ships. The other aids included Aids for Personnel, Material and Inspections. Neeser, "The Department of the Navy."

chaotic state than in the army."[37] The navy's 'embryonic state' consisted of four hydroplanes, three flying boats, and a tent camp. Not a single naval officer had passed the test to become a navy pilot. The report also notes specifically that the navy has "no dirigibles of any kind."[38]

The lack of American aviation development was particularly dire, as the General Board had concluded that airships had, "progressed beyond the experimental stage, and are now recognised and proved weapons of war."[39] The authors attributed delayed American aviation development in part to geography. The report pointed out that while rigid airships were not then capable of crossing the ocean, non-rigid airships were capable of this feat, and rigid airships soon would be. The authors also included a note regarding the threat of airpower for future combat. If the U.S.were to face an adversary with an air force, they argued, and without an American military aviation capability, the country would be hampered not only in fighting the aircraft in the air, but by collection of information, and protection of information regarding her own activities.

The General Board's 1913 report concludes, "steps should be taken at once to organize and train an efficient naval air service, including trained personnel in sufficient numbers and both aeroplanes and dirigibles, with all the accessories for their efficient use."[40] To attain this objective, the Board recommended the establishment of a Congressionally-

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36 General Board, "Memo Subject: Air Service in War," (Serial 449 Box 188; Records of the General Board; Record Group 80; National Archives Building, Washington, DC.: 1913), 3.

37 US army totals in March 1913 included a total of 17 flying machines, 5 military aviators, 11 officers capable of flying, and 8 under instruction. Seven additional airplanes were on order. General Board, "Memo Subject: Air Service in War," 5.

38 General Board, "Memo Subject: Air Service in War," 6.

39 General Board, "Memo Subject: Air Service in War," 5.

40 General Board, "Memo Subject: Air Service in War," 7.

funded Office of Naval Aviation headed by an officer not below the rank of Captain. The committee also cited the importance of giving this officer sufficient control of resources to ensure not only the construction of machines, but also the training of personnel.

By 1916, the General Board's case for airship development was becoming more defined and pronounced. In March, the Board suggested to the Secretary that, "in this country little or nothing is known as to the details of Zeppelins, but their performances are so remarkable that it is most necessary for the navy of the United States to develop dirigibles of this type as soon as possible."[41] The General Board's concern was not merely with falling behind in the development of the new technology, but also with the idea that the rigid airships of other countries might eventually become a threat to the United States.

The Board was experienced in traditional ship design, and well understood the time required to develop and effectively integrate the rigid airship into the navy.

> We cannot hope to have anything mechanically satisfactory in less than four or five years, even with the best efforts. In the meantime tactical uses will develop rapidly. Any delay may be most unfortunate for very large aircraft of this type are now available abroad for naval uses. In certain directions they can render services very difficult to secure by other means.[42]

After two years in which no decisions were made to invest in the airship, the General Board once again made specific recommendations on how to proceed, this time even naming the company that could be hired to design and build the airship. The Board's 1918 recommendations are very specific, and were accepted and endorsed by the Secretary of the Navy in September. The Board called for the construction of a total of six airships, two

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41 From letter from General Board to the Secretary of the Navy Subject: Necessity of Dirigibles. March 1, 1916 Signed Admiral George Dewey cited in Navy General Board, "Appendix V: United States Navy General Board Recommendations on Airships," (Folder 12, Box 10, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC), 1.

purchased commercially, and four built under the auspices of the navy. The airships were to use both hydrogen and helium gases to allow the navy to experiment with the different qualities of these two.[43] It may have been these last specific recommendations that were finally translated into the navy's first airship acquisition.

The main contribution of the Navy General Board to the acquisition of rigid airships was to provide continuity of analysis at a senior level. As a senior organization, the board was able to draw the attention not only of the Secretary of the Navy, but also Congress and the President toward airship acquisition. The General Board consistently emphasized the value of experimenting with the airship. In a 1926 report considering the rigid airship, the General Board suggested that without the ability to explore the airship's capabilities in combat, its only true use might be commercial.[44]

Joint Airship Board

One of the main means by which the Secretary of the Navy and other decision-makers gathered information regarding the aviation situation in the United States was through the use of temporary, subject-specific boards. Members of Congress, the navy, the army, the Department of Commerce, and other arms of the government convened these usually temporary organizations in an effort to understand particular aspects of aviation, or the aviation picture as a whole. In response to a General Board suggestion, a joint

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42 From General Board No. 449 Serial No. 486, March 1, 1916 subject: necessity for dirigibles General Board, "Subject: Rigid Airships. Recommendations of Joint Army and Navy Airship Board," 1.

43 Suggestions can be found in General Board, "Subject: Rigid Airships. Recommendations of Joint Army and Navy Airship Board," 7.This report was completed August 21, 1918 and approved by the Secretary of the Navy on September 4, 1918.

44 General Board, "Rigid Airships and Appurtenances - Policy Regarding," (Serial 449 Box 191; Records of the General Board; Record Group 80; National Archives Building, Washington, DC.: 1926), 2.

committee of navy and army officers was created in 1917 to consider the question of airship development.[45]

The Joint Airship Board included three navy officers and three army officers, who set quickly to the task of shaping airship development.[46] In February 1917, one month after its formation, the Joint Airship Board recommended obtaining an airship from abroad.[47] The main reason for acquisition from abroad was an acknowledgement of foreign capability and the lack of an American airship industry. Asked to amplify on this suggestion, the Joint Airship Board sent a team abroad to examine foreign construction methods. The team recommended that if airships were going to be used by the United States in the first World War, they should be obtained from England. If the airships were to be used from bases in the United States, the team recommended that an American company, "in a manner as to create the art in the United States," should construct the ships.[48] The Board recommended that as a starting point four airships, and the necessary facilities, be built.[49]

While the Joint Airship Board helped to solidify the General Board's suggestions in regard to airship acquisition, the key recommendation of the Joint Airship Board was that

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45 The General Board suggested this action in support of a recommendation by the Acting Secretary of War in a letter dated October 11, 1916. The General Board's opinion is written in 2nd endorsement GB No 449 Serial 615 October 19, 1916. Subject: Policy with Regard to Development of Zeppelins p. 2. An earlier letter written by Major General George O. Squier in October 1916 inquired as to the country's coastal defenses and suggested that the Navy might be best positioned to take on the long-range scouting issue. See Recollection of the Early History of Naval Aviation, p. 749.

46 The members of the Airship Board were D.W. Taylor, Chief Constructor, USN, V.L. Kenly, MG USA, H. H. Arnold Col, USA, J.C. McCoy, Maj, USA, A.K. Atkins LCDR, USN, J.C. Hunsaker Naval Constructor, USN2nd endorsement of memo from GB to SecNav p. 6 The Joint Airship Board would later become the Joint Army and Navy Board on Aeronautical Cognizance in 1919, taking on more than just the airship question. For more information see Albion and Reed, *Makers of Naval Policy, 1798-1947*, 366-368, 381.

47 Garland Fulton, "High Spots in the History of Rigid Airships in the Navy," (Folder 7, Box 6, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1930).

48 General Board, "Subject: Rigid Airships. Recommendations of Joint Army and Navy Airship Board," 5.

the navy, and not the army, be made the lead agent in rigid airship development. Congress would also take joint Airship Board recommendations for the acquisition of a foreign airship into consideration.

Operating navy

Beyond the three major organizations above, the operating navy also had views on the acquisition of the airship. The operating navy, in this study, is considered the more traditional, non-aviation portion of the navy. With a history dating to before the formation of the country, and emerging successful from the First World War, the operating navy of this period was focused on heavy battleships.

The operating navy's perspective on the rigid airship generally followed that of the General Board. The operating navy explicitly supported the airship as long as it seemed to occupy a position of use, and present no threat, for the 'battleship navy.' When the airship threatened more traditional platforms, in particular in the competition for funding, the operating navy turned solidly against it.

The navy of this period was still solidly locked in the grip of the concept of sea power, developed by Alfred Thayer Mahan during his time at the Naval War College.[50] Mahan's unique study of the role of sea power in conflict implied that sea power, above other factors, shaped historical development. Mahan's definition of sea power consisted of two factors:

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[49] Fulton, "High Spots in the History of Rigid Airships in the Navy."

[50] Mahan's two most famous works were A. T. Mahan, *The Influence of Sea Power Upon History, 1660-1783*, 15th ed. (Boston: Little, Brown and company, 1898). and Alfred Thayer Mahan, *The Influence of Sea Power Upon the French Revolution and Empire, 1793-1812*, 10th ed. (Boston: Little, Brown, and company, 1898).

1) Command of the sea through naval superiority; and,

2) A combination of maritime commerce, overseas possessions, and privileged access to foreign markets that produces national wealth and greatness.[51]

At the operational level, Mahan's perspective was more simplistic. In order to secure the best conditions in naval warfare, assets must be concentrated, in one area, and under one command. Mahan, who supported a navy of big ships, is famous for his dictum 'never divide the fleet!'

During the period of the airship, Mahanian principles were central to planning within the operating navy. Former army Colonel and Secretary of War Henry Stimson implied Mahan served as much more, describing, "the peculiar psychology of the navy Department, which frequently seemed to retire from the realm of logic into a dim religious world in which Neptune was God, Mahan his prophet, and the United States Navy the only true Church."[52]

The operating navy had inputs into strategic planning via the General Board and the House Naval Affairs Committee, through means of hearings and personal letters. In the days of deciding to invest in the airship, the role of the operating navy can be seen most clearly in personal communications. For example, then Captain Ernest J. King, on his return from duty in Europe, told the General Board that,

> I don't see how the long distance reconnaissance is going to be carried out without using dirigibles, and the rigid appears to be a better type for that

[51] Philip A. Crowl, "Alfred Thayer Mahan: The Naval Historian," in *Makers of Modern Strategy from Machiavelli to the Nuclear Age*, ed. Peter Paret (Princeton: Princeton University, 1986).

[52] Henry Lewis Stimson and McGeorge Bundy, *On Active Service in Peace and War* (New York: Octagon Books, 1971), 506. cited in George W. Baer, *One Hundred Years of Sea Power: The U.S. Navy, 1890-1990* (Stanford, Calif.: Stanford University Press, 1994), 114.

> than the non-rigid…There certainly does not seem to be any very great promise in airplanes for long-distance scouting. It would appear that you would have to go into the dirigibles for that purpose.[53]

Similarly, Admiral H. T. Mayo expressed his support for acquisition of airships in a memo to the Secretary of the Navy dated 24 November 1918. Mayo requested airplanes for reconnaissance, airfighting, torpedo delivery, and seaplanes. He also asked for rigid dirigibles for scouting and non-rigid dirigibles for patrol and escort duties.[54] In these "recommendations regarding future policy governing development of air service for the United States Navy," Mayo highlighted the poor state of American aviation development, especially in the field of aircraft carriers, and especially in comparison to the British Grand Fleet.

The operating navy also published their views and shaped the airship discussion through the press. In publications such as the *United States Naval Institute Proceedings*, and aficionado magazines such as *Air Power* and *Aeronautics*, they set not only the public discussion of airships, but also the promise of future expectations. Most of these articles focused initially on maintaining parity with the British airship program.

In letters and articles dating before the arrival of the navy's first airships, support from the operating navy seems high. The sheer number of articles dealing with airship issues, however, is very minor compared to articles discussing airplanes in the navy. It is only following the acquisition of the airships that the operating navy seemed to turn against

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53 U.S. Navy, Office of Naval History, General Board, Hearings, Vol II (1919), 953-54. Cited in Smith, *The Airships Akron and Macon*, xxi.

54 Admiral Henry Thomas Mayo, Commander in Chief of the Atlantic Fleet, also highlighted the lack of American aviation development overall, especially in comparison to Great Britain. From Commander in Chief Atlantic Fleet, "Recommendations Regarding Future Policy Governing Development of Air Service for the United States Navy," (Serial 449 Box 189; Records of the General Board; Record Group 80; National Archives Building, Washington, DC.: 1918).

the airship concept. The role of the operating navy in deciding against airships will be discussed in detail in chapter five.

Congress

During the period of investment in the rigid airship, the House Naval Affairs Committee played a strong role in shaping not only naval acquisition, but also navy strategy and long-term planning. Members of the Naval Affairs Committee, led by Thomas Butler, consistently defended the naval budget through a period of relative hostility to naval spending. The congressional history of airship support, more than any other organization, is driven by budget considerations.

The organization of Congressional funding in this period tended to limit input from active duty naval officers. The Congressional Director of the Budget held strong sway over funding levels and even specific programs. As a result of this power, during the 1920s the Directors of the Budget also had a strong, nearly direct effect on naval strategy. The Directors established limits on shipbuilding, personnel, and fleet operations to the degree that one naval historian suggests that, "to the navy and a few congressmen it therefore appeared that naval policy was being set by a new and powerful bureaucracy over which they had no control."[55] The role of directors of the budget limited effect of both the naval affairs committee and the larger Congress.

Following the First World War, President Wilson came out in favor of continuing his 1916 naval expansion program which had been put on hold during the war. The plan had been designed to provide the United States with a navy ‘second to none.’ Funding and ship requirements would be determined by the requirement to defend both the Atlantic and

Pacific coasts. Many were surprised by Wilson's support for the plan which included ten new large battleships. Wilson even supported increasing the spending plan such that by 1925 the navy's order of battle would include thirty-nine dreadnoughts and twelve battle cruisers.[56]

In the spirit of this increased spending, two months before the armistice, the General Board submitted a recommended naval aviation program that would include heavier and lighter-than-air assets, support facilities, and funding for training. The program, designed for the naval appropriation bill of 1920, totaled $225,000,000, a ridiculously large sum, especially given the end of the war. The plan included nineteen naval airship stations and a total of 130 airships, rigid and non-rigid.[57]

Even while funding for naval assets was at a high level, the funding available for aviation had to be split between lighter-than-air and heavier-than-air assets. Congressman Butler, noted that: "after making some necessary allowances for the cost of experimental work, hangars, sheds, &c., it is estimated that there remains a total of only $360,000, which represents the amount that can be expended…for new aircraft. This sum will purchase twenty-four airplanes with no dirigibles, or one dirigible with no airplanes."[58] Throughout its tenure the airship would be compared on budget sheets against the airplane.

In addition to the challenge of explaining and selling naval strategy to the Directors of the Budget, naval leadership struggled with a public relations challenge. In the words of

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[55]Paolo Enrico Coletta, *American Secretaries of the Navy* (Annapolis, Md.: Naval Institute Press, 1980), 589.

[56] Harold Hance Sprout and Margaret Tuttle Sprout, *The Rise of American Naval Power, 1776-1918*, 1966 ed., Classics of Naval Literature (Annapolis, Md.: Naval Institute Press, 1990), 55. Cited in Nathan Miller, *The U.S. Navy: A History*, 3rd ed. (Annapolis, Md.: Naval Institute Press, 1997), 194.

[57] Naval Affairs Committee (House) Hearings, 65th Congress 2-3 session 1918-1919.

one naval historian, “neither the nation nor its congress was dedicated to the proposition that navies were really necessary.” [59] To many in Congress and the American public, it seemed that, “naval reductions would mean tax decreases, each could also hope that every vessel scrapped or blueprint shelved would lessen the possibility of future wars. In many ways the navy worried more about such a national outlook than it did about Congressional miserliness”[60]

The 1920 naval appropriation was finally whittled down from the General Board’s suggested $225,000,000 to a total of $25,000,000, of which seven million would be directed at naval aviation. Drawing heavily on the findings of the Joint Airship Board, the bill directed the acquisition of two large rigid airships, one from the English Vickers Company, which had supplied the Royal Navy, and one to be constructed in the United States. [61] The idea was to gain experience in the engineering issues associated with airship design and construction, and obtain a validated vessel before beginning to build an airship industry in the United States.[62] The seven million dollars earmarked by the naval appropriation bill of 1920 also included construction of an airship hangar at the naval air

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58 "We Are Behind in Aircraft," *New York Times*, January 21 1915.

59 Wheeler, *Prelude to Pearl Harbor; the United States Navy and the Far East, 1921-1931*, 83.

60 Wheeler, *Prelude to Pearl Harbor; the United States Navy and the Far East, 1921-1931*, 129.

61 The 1920 Naval Appropriation Bill appropriated $1,500,000 for construction of one rigid airship, $2,500,000 for purchase abroad of a second, and about $3,000,000 for the construction of two sheds. Fulton, "High Spots in the History of Rigid Airships in the Navy."

62 The Vickers Limited was the Royal Navy’s producer of airships, but Vickers engineering organizations were involved in many other aspects of technological development in Britain in the late 19th and early 20th centuries. For more information about the company, see J. D. Scott, *Vickers, a History* (London: Weidenfeld and Nicolson, 1962).

base in Lakehurst, New Jersey.[63] The first airship, built in England, was known there as the R-38.[64]

Work actually began on the R-38 in February 1919, even before American interests became apparent. The R-38 was the most updated in a line of British airships destined for naval service. The airship sported new design features, including the carriage of twelve bombs, and twelve machine guns.[65] British development on the R-38 was halted in late 1919 when spending cuts caused the British Treasury to request cancellation of the vessel. When the American Navy became involved, the R-38 was the largest, most airship ever constructed, and was already 50 percent completed, promising an early delivery.[66] The United States Congress paid $2,000,000 for the airship and training of American naval personnel.[67]

In fact, the R-38 concealed structural flaws related to the new aluminum used in her construction.[68] The American naval personnel who went to England to learn to operate the ship, eight officers and eighteen enlisted men, initially trained on sister vehicles. Naval engineers requested various safety and structural data, but did not receive it on schedule. Two short trial flights also seemed to demonstrate that the navigational fins were far too

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[63] A later article notes that Lakehurst lies at the mid-point between Boston, Massachusetts and Cape Line, Virginia, an area of heavy population and with many cities of military importance. "Why Lakehurst?" (Folder 10, Box 1, George Henry Mills Collection (Acc. 1994-0022). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1933), 1.

[64] In the Navy's ship appellation system, Z stands for airship, and R for rigid.

[65] Robin D. S. Higham, *The British Rigid Airship, 1908-1931: A Study in Weapons Policy* (Westport, Conn.: Greenwood Press, 1975).

[66] Garland Fulton, "Brief Historical Outline of Rigid Airship Design," (Folder 7, Box 6, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1935), 8.

[67] Fulton, "High Spots in the History of Rigid Airships in the Navy."

weak, and the whole airship unbalanced.[69] However, after repairs and reinforcement, the airship was scheduled for delivery in August 1921 to the newly-constructed American airship base at Lakehurst, New Jersey. During her fourth flight, the airship broke in half and burned on August 24, 1921. Forty-four of the forty-nine men aboard were killed.

According to the commanding officer of U.S. Navy's detachment in England, the R-38 left Royal Air Force Airbase in Hozden, Yorkshire, England at 7:10AM on August 23, 1921 for trials before she was handed over to the navy. Commander Louis Maxfield was the commanding officer. A total of seventeen U.S. Navy personnel were on board, six officers and eleven enlisted.[70] Maxfield and fifteen others were killed when the R-38 crashed after a few hours in the air. According to one civilian survivor, "The ship had just completed her first full-speed test… [the accident] was swift and complete. My feelings were that the ship was shaken three or four times in a lateral direction, and a few times in a longitudinal direction. The explosion followed, and we knew that we were doomed. The tail of the ship fell down and I was thrown into the cockpit."[71]

Congress had lost over two million dollars on the airship, although it would never fly in the United States. The loss came just days before the Bureau of Aeronautics, under the leadership of Admiral Moffett, came into existence. It would be up to Moffett and the airship advocates to negotiate for a replacement airship.

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[68] For further detail on the aluminum used in R-38's construction and the Vickers company who constructed the airship, see Margaret B. W. Graham, "R&D and Competition in England and the United States: The Case of the Aluminum Dirigible," *The Business History Review* 62, no. 2 (1988).

[69] For a detailed discussion of the technical aspects of the R-38's initial flight, see Douglas Hill Robinson, *Giants in the Sky: A History of the Rigid Airship* (Seattle: University of Washington Press, 1973), 168-175.

[70] US Naval Airship Detachment Yorkshire Commanding Officer, England, "Loss of the Rigid Airship Zr-2," ed. Secretary of the Navy (Yorkshire, England: Folder 1, Box 9, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC, 1921), 1.

Conclusion

Several high-level organizations were at the heart of the decision to initiate investment into the airship for the United States Navy. The most important organization was the Navy's General Board, a small group of senior officers chartered to oversee strategic planning and investment for the navy. The General Board was also responsible for ensuring that strategic plans were solidly-developed and supported by the navy's infrastructure. The General Board decided to invest modestly in the airship in response to studies suggesting that the airship had performed well during World War I and could be useful as an American asset. They were supported in this view by the Naval Affairs Committee of Congress, and a specially-convened group, the Joint Airship Board.

The commitment by these national-level organizations to the airship indicates high-level interest in the airship, but not interest at the level of the operating navy. The major investment decision was also made by groups, rather than by individuals. It was not until Admiral Moffett became involved that a high-ranking individual would attach his name to the program.

While national level organizations expressed their interest in investing in the airship, the initial investment was quite limited. The General Board in particular cited its interest in acquiring the airship for experimentation. How the airship would fare in

[71] Commanding Officer, "Loss of the Rigid Airship Zr-2," 2.

experiments, however, fell to the airship advocates, and would eventually be decided not by the General Board or Congress, but by the operating navy.

Chapter 4: Airship Advocates (1921-1928)

The years between 1921 and 1928 were decisive for the rigid airship in the navy. During this time all of the navy's five airships were in flight. They participated in scientific and performance experiments, tested new equipment and configurations, flew in exercises with the fleet, and contributed to publicity events. Four of the five were also destroyed, three by in-flight accidents. The navy's last airship would crash by 1935.

Between 1921 and 1933 the airship advocates also had their best chance of making the rigid airship an integral part of the navy's fleet. At the beginning of the period, Congressional support for the airship and naval aviation led to the creation of the Bureau of Aeronautics within the navy. The airship advocates came together within this organization to push for publicity, improvement, and adoption of the airship within the navy.

These advocates were not the only individuals arguing for a greater presence of the rigid airship in navy plans and operations, however, they were the most relevant within the naval establishment. Outside the establishment, engineers such as Hugo Eckener and Jerome Hunsaker tried to further airship development and investment. Congressional leaders such as Carl Vinson and Thomas Butler fought for funding for the airship as well.

The advocates were led by the larger-than-life Admiral William A. Moffett. Between 1921 and 1928, Moffett held the position of chief of the Bureau of Aeronautics, the top position in naval aeronautics. Garland Fulton, his assistant and technical expert oversaw the development of new airship models including the aircraft-carrying *Akron* and *Macon*. Charles E. Rosendahl served as the commanding officer of two of the airships.

This chapter will track the interactions of these four key players between 1921 and 1933. Each of the advocates will be introduced at the point at which they entered the airship field. Discussions of each will include a general biography and information on how they pursued advocacy of the airship as well as how they interacted with each other.

A New Bureau: 1921

The airship advocates began the key period of influence over the navy's rigid airship program in 1921, with the creation of the Bureau of Aeronautics. The creation of Bureau of Aeronautics was the result of the combined efforts of navy leaders, the National Advisory Committee for Aeronautics, and Congressional supporters.[1] Secretary of the navy, Edwin Denby, hoped that the Bureau would be endowed with the "same rank as other bureau chiefs… and the power to administer the affairs of aviation as distinct from the other branches of the service."[2] The Bureau was to take control of, "all that relates to the designing, building, fitting out, and repairing of naval and Marine Corps aircraft."[3] Certain facets of airship construction would be handled by appropriate other bureaus, such as aircraft compasses and instruments for aerial navigation, which fell to the Bureau of Navigation. Also, the Bureau of Aeronautics was limited to making recommendations to the Bureau of Navigation for officer personnel details.[4]

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1 The Bureau was created by a House Bill (HR 273) introduced by Congressman Hicks in April of 1921. It passed the Senate as S. 656. See Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 47-77.

2 Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 77.

3 "Establishment of the Bureau of Aeronautics, General Order #65," (Serial 449 Box 190; Records of the General Board; Record Group 80; National Archives Building, Washington, DC.: 1921), 1.

4 "Establishment of the Bureau of Aeronautics, General Order #65." Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 77-79.

The creation of the Bureau, with Admiral Moffett at its head, represented a significant victory against aviation opposition forces within the navy. One of these oppositionists was the Chief of Naval Operations, Admiral William S. Benson. Benson was overheard saying that, "the navy doesn't need airplanes. Aviation is just a lot of noise."[5] The establishment of an official bureau, in competition with others for control of plans and budgets demonstrated Moffett's close connection with Congressional leaders.

Moffett approaches the podium for one of his many radio addresses.

When he became Chief of the Bureau of Aeronautics in 1921, Admiral Moffett already had a successful naval career behind him. He was the quintessential naval officer of the early twentieth century. Moffett graduated from the naval academy and served as an

[5] Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 71.

ensign onboard the cruiser *USS Chicago* under the command of Captain Alfred Thayer Mahan. He became a distinguished surface warfare officer before his foray into aviation began.

Moffett's attitude is best described by his Medal of Honor citation for his role in the 1914 battle of Vera Cruz. The citation for his Medal of Honor noted that Moffett, "…brought his ship into the inner harbor during the nights of the 21st and 22nd without the assistance of a pilot or navigational lights, and was in a position on the morning of the 22nd to use his guns at a critical time with telling effect. His skill in mooring his ship at night was especially noticeable. He placed her nearest to the enemy and did most of the firing and received most of the hits."[6]

This view of Moffett in combat provides insights to his approach to the rigid airship situation. Moffett saw himself in a combative environment in regards to the rigid airship. He approached challenges from 'the enemy' head on, and made himself the public and authoritative face of the navy's airship program. A contemporary journalist described Moffett as a 'smallish pepperbox of a man"[7] His 'enemies,' the upstart army officer Billy Mitchell and non-believers within the navy, provided as many challenges to Admiral Moffett as did the difficult technical workings of the airships themselves.

Despite his battleship background, Moffett was very interested in proving the capability of aviation to 'provide support to the fleet.' From this position, he provided a threat to the traditional operating navy. Moffett even declared publicly that battleships were becoming obsolete. However, as one journalist described him, "Moffett is by no

[6] "Moh Citation for William Moffett," (2006).

means a theatrical reformer. Never is he wanting in respect for his superiors… To be hailed as a hero would be repugnant to him."[8] In fact his great talent came in managing careers, individuals and personal relationships. Naval historian George W. Baer describes Moffett as, "in his own right an organizational genius."[9]

Moffett's battle for the airship began nearly from the first day he took over as chief of the Bureau of Aeronautics. By that time, the navy, and Congress, had already made a strong commitment to the rigid airship, including appropriations for the construction of two airships in 1919. However, by 1921, construction of the first of these airships had slowed due to delays in design and delivery of duralumin, the airship's structural material.[10] Moffett had to draw on his personal connections with key influential leaders such as Secretary of the Navy Denby, Assistant Secretary of the Navy Theodore Roosevelt, and the Chief of Naval Operations to channel more money toward the project.[11] Soon after taking over as bureau Chief he wrote to the Chief of Naval Operations, stating, "In the rigid airship we have a scout, capable of patrolling the Pacific in the service of information for our Fleet… THE USE AND DEVELOPMENT OF RIGID AIRSHIPS IS A NAVAL NECESSITY" [emphasis in original].[12]

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[7] W.B. Courtney, "Lighter Than Air," *Collier's* (1931): 18.

[8] Courtney, "Lighter Than Air," 18.

[9]Baer, *One Hundred Years of Sea Power: The U.S. Navy, 1890-1990*, 141.

[10] Duralumin is "an alloy of aluminum, copper, magnesium and silicon and is one-third the weight and the same strength as structural steel." See Starr Truscott, "New Rigid Airships," *Scientific Monthly* 2, no. 6 (1926).

[11] Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 126., Coletta, *American Secretaries of the Navy*, 595.

[12] Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 125.

Although Moffett is easily the best known of the airship advocates, historians have tended to emphasize his support of heavier rather than lighter-than-air.[13] Some historians such as Moffett Biographer William F. Trimble write off his support of the rigid airship program as a flight of folly. However, Moffett's support for the airship was neither absolute nor blind. When the airships began to have difficulties with ground handling he insisted that his support for the airship was on the condition that it could operate in support of the fleet, at a distance from its home base.[14]

Trimble traces Moffett's support for the rigid airship in the Naval Conference of 1922. The conference, held in Washington from November 1921 through February 1922 was the result of growing efforts to limit a growing naval arms race. Naval officers played a secondary role in the effort led by the State Department. Moffett, however, played a strong role by chairing the subcommittee on aviation. The conference culminated in a series of agreements, including the Five-Power Naval Limitation Treaty. For the five signatories, the treaty delineated limitations on the number and size of battleships that could be completed or acquired, and imposed a ten-year 'battleship holiday' in which no new battleships would be constructed.[15] For the field of naval aviation, the conference served as a sort of incentive. Moffett's subcommittee had determined that limiting aviation

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[13] See Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 126. and Edward Arpee, *From Frigates to Flat-Tops; the Story of the Life and Achievements of Rear Admiral William Adger Moffett, U.S.N., "the Father of Naval Aviation," October 31, 1869-April 4, 1933* ([Lake Forest, Ill.: 1953).

[14] In a 1931 letter Moffett wrote to Shoemaker, the commanding officer of the Lakehurst facility, stating that he supported the airship only as it was able to use the mast to avoid being pinned in its hangar during bad weather. See Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 260. and Arpee, *From Frigates to Flat-Tops; the Story of the Life and Achievements of Rear Admiral William Adger Moffett, U.S.N., "the Father of Naval Aviation," October 31, 1869-April 4, 1933*, 236-237. for copies of the letter.

[15] The five signatories included the United States, United Kingdom, France, Italy, and Japan. For the full documentation of the treaty, see http://www.ibiblio.org/pha/pre-war/1922/nav_lim.html Papers Relating to the Foreign Relations of the United States: 1922, Vol. 1, pp. 247-266.

assets was impractical as any nation could build and hide aircraft and/or quickly develop a high production facility as needed in time of war.[16]

For the larger navy, and in part for the airship program, naval treaties of the period would direct senior-level planning and technology investment. Naval historian George Baer argues that navy planning in this period was connected to national diplomacy only through naval treaties limiting arms.[17] Trimble suggests that during the Washington Naval Conference Moffett was introduced for the first time to the limitations on surface assets and the challenge of potential operations in the Pacific theater. It was perhaps during this period that Moffett came to see airships as a potential technological solution for these issues.

In addition to providing a possible solution for coming operational challenges, the airship represented for Moffett a means of publicizing the navy's aviation program writ large. One of the initial 'publicity' efforts that Moffett introduced was the use of rigid airships as vessels of exploration to the Arctic and Antarctic.[18] He suggested in a press release in June 1921 that the ships might be used to facilitate geological, atmospheric, and astronomical research in the polar regions, and possibly carry airplanes as shuttles for side trips.[19]

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16 Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 96-98.

17 Baer, *One Hundred Years of Sea Power: The U.S. Navy, 1890-1990.*

18 The idea of using a lighter-than-air craft to explore the poles had been around since at least the late nineteenth century. Being the first to achieve this goal would have brought international acclaim. See "Ballooning to the Pole," *New York Times*, December 6 1890.

19 William A. Moffett, "Airships and the Scientist - Press Release 089," (Roll 15, William A. Moffett Papers; United States Naval Academy: 1921). Cited in Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 129.,

While he began his tenure as Chief of the Bureau of Aeronautics with high hopes for the rigid airship program, Moffett suffered an early setback with the loss of the navy's first airship, the R-38. The loss of the airship, which never reached the United States, was a blow to the navy's program, but the greatest loss may have been the airship expertise onboard. Airship historian Douglas Robinson noted that commanding officer Louis Maxfield's death was particularly difficult because, "it was largely due to his enthusiasm and energy that the Department (and the General Board) agreed to approve a rigid airship program and the Lakehurst [New Jersey] station."[20]

Jerome Hunsaker, a naval airship constructor at the time of the accident wrote that, "The United States was perhaps at fault in not detailing a competent naval constructor and an engineer to act as inspectors with the usual full authority."[21] Following the accident the United States Navy lost faith in British construction expertise and turned to a more reliable producer. Moffett also identified a subordinate with the technical training to ensure the success of future airships.

Moffett and Fulton: The Front Page and the Blueprint

While Moffett represented the publicity concerns of naval aviation, his assistant Captain Garland Fulton supplied the technical expertise. This was not the first time the men worked together. Moffett had worked with Fulton before either one of them arrived in the airship program. After he graduated from the Naval Academy in 1912, Fulton's first assignment took him to sea onboard the *USS Arkansas*, a battleship commanded by then

[20] Hunsaker Vol VI p15, cited in Robinson, *Giants in the Sky: A History of the Rigid Airship*, 188.

[21] Hunsaker, vol. VI, p. 15 cited in Robinson, *Giants in the Sky: A History of the Rigid Airship*, 189.

Captain Moffett. Early in his assignment, Fulton was chosen to be Moffett's aide.[22] After completing a master's degree from MIT, Fulton requested to be transferred to aeronautical engineering in the Bureau of Construction and Repair where he remained until his transfer to the newly-created Bureau of Aeronautics in 1921.

More so than any of the other airship advocates, Fulton mastered the technical knowledge of airship design, construction, and operation.[23] While one historian refers to him as, 'Mr. Rigid Airship' of naval aviation, his view of the airship was always more closely allied to its blueprints and structural design than the flying experience he gained.[24] He spent nearly his entire airship career working as an engineer in the Bureau of Aeronautics. While he flew in airships, he never became a qualified airship officer and was not involved with the operational challenges associated with the ships.

Fulton's expertise in technical matters made him of central importance to Moffett as soon as he arrived at the Bureau. His first task was to oversee the construction of the replacement to the R-38. The acquisition of the replacement for R-38 took a decidedly unusual path. While Congress and the United States Navy were focused on acquiring a second airship from England, the army, in the form of Brigadier General William "Billy" Mitchell was making its best effort to obtain an airship from Germany. Mitchell sent the reliable Colonel William N. Hensley, former head of the army Balloon School, on a trip to Europe. He was instructed to find out as much as possible about airships and airship

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[22] Fulton, "Recollections of the Early History of Naval Aviation," 747.

[23] See Robinson and Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935*, 118-124.

[24] Smith, *The Airships Akron and Macon*, 8.

stations in England, and if possible France, Germany, and Italy. He also had confidential instructions to contact the German Zeppelin Company.

Mitchell's efforts in this regard were particularly audacious given the Joint Airship Board's 1920 decision allocating rigid airship development to the navy, and more importantly, the fact that the United States was still technically at war with Germany.[25] While Mitchell's plan was doomed to failure, the connection made between Hensley and the Zeppelin Company would establish the first steps to what would become the navy's ZR3, the *Los Angeles*.

As the Versailles Treaty took effect in Europe, the allies began to divide the spoils of German defeat, including her aircraft. A special board, the Inter-Allied Aeronautical Commission of Control (IAACC), headed by a Royal Air Force Brigadier, was charged with enforcing the Air Clauses of the Treaty. For the German lighter-than-air fleet, this meant distributing the remaining rigid airships to the allies, and destroying most sheds. At the time of the allotment the commission was unaware that crews from the German Navy had taken matters into their own hands and destroyed five of the airships on the allotment list.

The commission ruled, however, that the German government would have to pay for the lost airships either in gold marks or by construction of comparable civil airships at no cost to allies who wanted them. Leaders in the army Air Service were quick to convey to the Secretary of State that the United States would benefit from one of these airships. However, by the time the contract was signed for construction of the war reparation craft,

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[25] The refusal of the U.S. Senate to ratify the Versailles Treaty meant that official wartime status with Germany would endure until a separate peace was established on 28 October, 1921.

the Joint Airship Board's ruling of navy dominance in airship development had been remembered. The new airship, once complete, would join the navy's fleet.

In response to the crash of the R-38, Moffett insisted on better technical oversight for both the American-built *Shenandoah* and the German-built *Los Angeles*. For the *Shenandoah*, Moffett requested the nation's foremost aeronautical research organization, the National Advisory Committee for Aeronautics (NACA) to review the design for the airship.[26] For the *Los Angeles*, Moffett sent Fulton to oversee the design and construction work in Friedrichshafen, Germany.

Table 3: Garland Fulton. National Air and Space Museum Photo ref no. 9A00593

[26] NACA concluded, after fifteen different studies, that the airship design was solid and the airship would not be destroyed under conditions similar to those that destroyed the R-38.

During his two years in Friedrichshafen, Fulton was responsible for assuring the quality of construction. In addition to averting a design disaster such as occurred with the R-38, Fulton had responsibility for planning some media flights for the new airship once it was delivered in the United States. A private firm was hired to develop a plan for pictures, news, radio, and moving pictures.[27] Fulton reported directly to Moffett on this and other matters.

Fulton's public work was generally directed at a smaller audience than that of Moffett or later Rosendahl. Fulton offered insights and formulas to groups of engineers and those most interested in the scientific implications of the new airships.[28] Fulton had a solid belief in the future of the airship within the navy. Even when addressing highly technical audiences he felt it important to mention that, "I do not think there is any room for doubt as to the ultimate future of the airship as a means for bridging long over-water distances, and one thing stands out clearly-the use and handling of large airships is intimately bound up with marine knowledge. Big airships are a sailor's job."[29]

While Fulton oversaw the development of the new airship, Moffett continued to provide support for the airship from his new position at the Bureau of Aeronautics. Moffett maintained a correspondence and regular communications with members of Congress, the American public, and the press.

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27 Garland Fulton Inspector of Naval Aircraft, "Publicity for Zr-3," ed. Chief of the Bureau of Aeronautics (Folder 2, Box 9, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC, 1923).

28 An example typical of Fulton's technical writing can be found in Garland Fulton, "Some Matters Relating to Large Airships," (Folder AC 2/77-B296-F22; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1925).

29 Fulton, "Some Matters Relating to Large Airships," 13.

From the beginning of his tenure at the Bureau of Aeronautics, Moffett was also at the bull's eye of anyone targeting the airship program. A magazine journalist from Collier's summarized the situation: "It wasn't an easy decision Moffett had to make the day he sat for the first time in his present chair. Not only public horror and newspaper indignation, but a two-fisted attack from within his own navy deafened and muddled him."[30] From his senior position, Moffett had the most control over where and how the airships themselves would be used.

Beyond airships, Moffett's position gave him responsibility for development of the navy's heavier-than-air program as well. He saw both as integral to the future of the navy. In a letter to Navy Secretary Denby in the summer of 1922, Moffett wrote: "the navy is the first line of offense and naval aviation as an advance guard of this first line must deliver the brunt of the attack. Naval aviation cannot take the offensive from the shore; it must go to sea on the back of the fleet."[31] This was a sentiment that Moffett would repeat in the public press for many years into the future.[32]

By the end of 1922, the navy's policy regarding lighter-than-air was well-established and would serve as the basis for future policy decisions for years to come. On December 1, 1922, the Secretary of the Navy approved the policy as follows:

> To complete rigid airships now under construction and to determine from their performance in service the desirability of further construction…
> To direct the principal air effort on that part of the air service that is to operate from ships of the fleet.

[30] Courtney, "Lighter Than Air," 18.

[31] Coletta, *American Secretaries of the Navy*, 595.

[32] Among other outlets, Moffett printed this statement in Charles E. Rosendahl, "Some Aviation Fundamentals," *United States Naval Institute Proceedings* 51, no. 272 (1925).

> To give every possible encouragement to aviation in civil life with a view to advancing the art and to providing aviators available for war.[33]

The potential dangers for the rigid airship can be seen in this early policy document. The number of airships was already limited: only those under construction would be completed, until they proved their value to the fleet though performance. Also, rigid airships at the time were planned to fly only limited operations with ships of the fleet. They would communicate, operate, and refuel with specially-outfitted ships such as the converted oiler *USS Patoka*. However, the majority of the time, the rigid airships would be based in hangars ashore. The navy policy clearly helped push the advocates toward proving the airships' performance with the fleet.

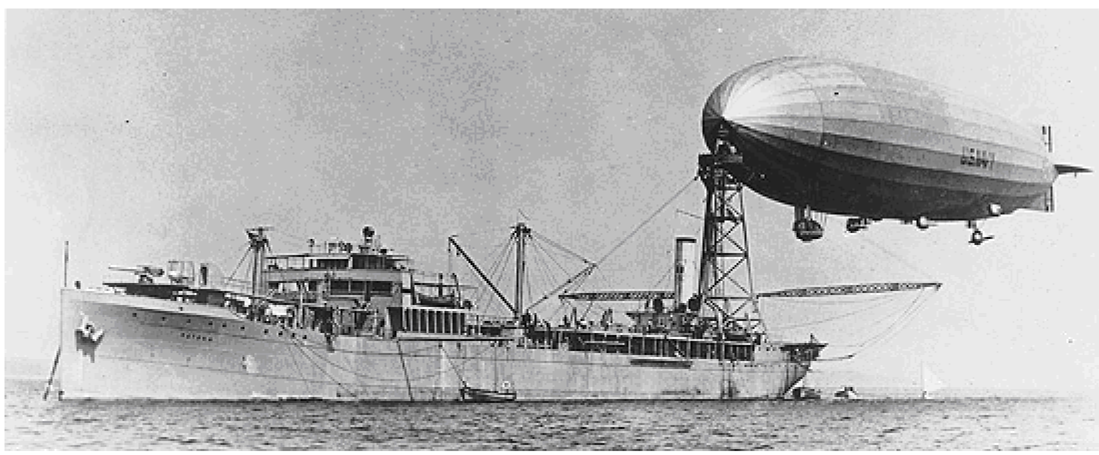

Table 4: Naval Historical Center Photo #NH57994 *USS Shenandoah* Moored to *USS Patoka*, circa 1924.

Shenandoah and Los Angeles – Building the Airship Fleet

In 1923 and 1924, the navy's first two airships took their maiden flights. The *Shenandoah*, christened by the wife of the Secretary of the Navy, took to the skies in early September 1923. While the two airships began operations with the navy, the first cohort of

[33] Charles E. Rosendahl, "Information on Ligher-Than-Air," (Folder AC 2/77-B-140-F62; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1936).

airship students, naval officers and enlisted men, began coursework at the naval air station in Lakehurst.

Shenandoah's main mission was the development of new airship ground handling equipment and the training of personnel. According to historians Ventry and Kolesnik, the *Shenandoah*, "was used mainly on an experimental basis to iron out the problems associated with the use of helium lifting gas. In particular, all sorts of experiments were made to increase or decrease the lift of the ship through superheating or supercooling."[34]

Superheating and supercooling refer to the use of temperature changes of the earth and air between day and nighttime to enhance the lift of helium in the airship. An airship removed from its shed while the ground is still cool will benefit from the increase in lift from the rising of the sun and heating of ground and air around it while the opposite is true for a ship returning in the evening. These measures were particularly important due to the limited supply of helium. Other than superheating and supercooling, airship crews had to rely on the influx or release of helium (which was in very limited supply) to effect changes in altitude.

In addition to experimentation, *Shenandoah* became a key advertisement for the navy's aviation program. In 1924 the Bureau of Aeronautics proposed that the *Shenandoah* be sent on an exploration mission to the Arctic Region. In the breathless words of the *Washington Post*, "The obvious duty of the United States Navy is to go into the Polar Sea and complete the exploration of the world."[35] Moffett applied to become the commanding

[34] Ventry and Koleâsnik, *Airship Saga: The History of Airships Seen through the Eyes of the Men Who Designed, Built, and Flew Them*, 143.

[35] "The Shenandoah," *Washington Post*, January 18 1924.

officer of the expedition himself.[36] Congress opposed the idea, citing cost and potential damage to the new airship. Their views were fueled by the commanding officer of the *Shenandoah* who suggested that the ship might be lost in the Arctic wastes. After Moffett dismissed the officer, it seemed the publicity mission might go forward.

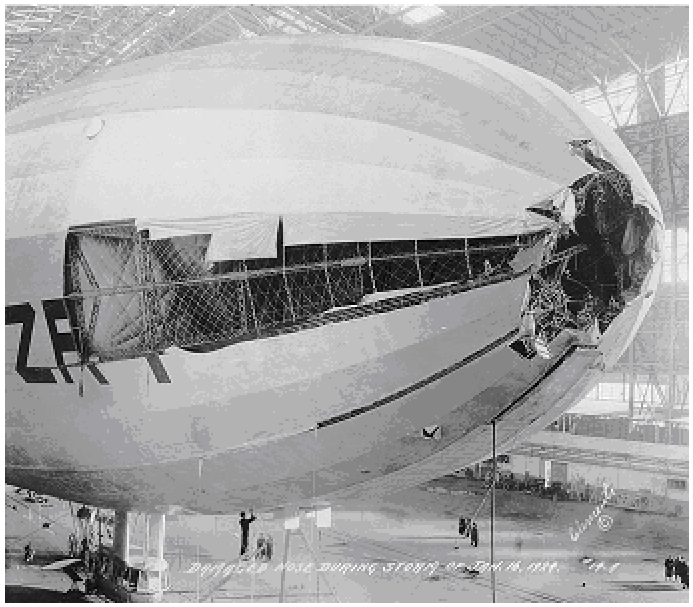

Table 5: Naval Historical Center Photo #NH92612 Damage to *USS Shenandoah*'s Nose, from Storm of 16 Jan 1924

It was only a few days following Congressional hearings on the expedition that *Shenandoah* suffered major damage, settling the issue. In January 1924 "a seventy-mile gale swept over the Jersey flats and ripped the *Shenandoah* from the cables lashing her to her mast."[37] The *Washington Post* ran the front-page headline: "Airship *Shenandoah*, with 22 men aboard, torn loose by gale, is drifting to sea."[38] According to Fulton, "the damage

[36] William A. Moffett, "Memo Regarding Polar Expedition," (Folder CM-513000-02, William Moffett Collection. Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1924).

[37] Howard Mingos, "Shenandoah Disaster a Costly Lesson to Aviation," *New York Times*, September 6 1925.

[38] "Shenandoah, with 22 men aboard…" from proquest

which the *Shenandoah* withstood successfully on this occasion was remarkable."[39] Fulton further described the *Shenandoah*'s condition after she was injured as comparable, "to that of a steamship putting to sea in a 75-mile gale with her bow torn open, two forward compartments flooded, and more than half the rudder gone."[40]

The advocates pointed to the *Shenandoah*'s 'adventure' of January 1924 as proof that airships were not at all fragile, unsafe, or unreliable and that storms did not present quite the threat they had previously thought. Some journalists seemed to agree, labeling the event a, "more dangerous test than any that will probably be encountered"[41] in flying to the pole. This was not the impression of Congress or the rest of the navy. The arctic expedition was cancelled.

While the *Shenandoah* would not go to the pole, she was detailed to provide direct support to the fleet in 1923. Between the first and second World Wars, the operating navy was divided into two parts, with the majority of the operating forces under the Commander in Chief, United States Fleet (CINCUS). CINCUS was in turn subordinate to the Chief of Naval Operations, the senior military officer of the navy. Under CINCUS, the Battle Fleet held the most modern battleships and newly-arriving aircraft carriers in the Pacific while the Scouting Fleet in the Atlantic had older battleships, cruisers, and destroyers.[42] This split was based on the perception of greater threat from Japan.

Under command of LCDR Zachary Lansdowne, *Shenandoah* participated in several scouting exercises with the battleship Texas. These exercises were designed to test the

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39 Fulton, "Some Matters Relating to Large Airships," 11.

40 "The Shenandoah."

41 "The Shenandoah."

ability of the *Shenandoah* to find a surface vessel at sea and report its location back to the fleet. Lansdowne and the crew also worked at perfecting the mooring process on the Patoka, achieving a new record of 19 minutes.[43] Richard Smith points out that while she was able to find the enemy with the Scouting Fleet, she suffered mechanical difficulties and had to withdraw from the exercise early.

The *Shenandoah* was then directed to support the Scouting Fleet in the Atlantic, beginning 1 August 1924. The commander of the Scouting Force, Admiral Newton A. McCully, commented that, "her [*Shenandoah*'s] possibilities should not be measured by this experience; with further experience she will undoubtedly improve her performance and will be a valuable adjunct to the Scouting Fleet."[44] But for many within the operating navy, what was remembered was that the *Shenandoah* was not sufficiently sound to operate with the fleet.

Some within the leadership of the navy reflected this view. When the Director of Naval Intelligence spoke about aviation and the navy in 1923, he made rousing comments on the future of the airplane, and barely a mention of the airship.[45] The navy's chief budget officer stated regarding the *Shenandoah*: "I have been very outspoken against it, would like to see it gotten out of the way, would like to see it stop taking ten percent of your very little funds away from you which might very much better be devoted to getting airplanes."[46]

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[42] Al Nofi, p. 6-7. See also Julius Furer, Administration of the Navy Dept in WWII p. 175-186.

[43] Commanding Officer of Patoka to BuAer, 23 July 1925, RG 72 General Correspondences 1925-1942 box 5564.

[44] Smith, *The Airships Akron and Macon*, 3.

[45] Luke McNamee, "Aviation and the Navy," (Serial 449 Box 190; Records of the General Board; Record Group 80; National Archives Building, Washington, DC.: 1923).

[46] Report of Bureau Conference, 23 September, 1924, Conference Reports, vol. 2, box 16, BuAer, Confidential Correspondence, 1917-1941, RG 72, NARA. Cited in Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 131.

While the ten percent was an erroneous assessment, the budget officer's assertion that the airship was drawing funding from airplanes was a view highly supported in the larger navy.

In addition to selling the unique capabilities of the airship, Moffett also tried to convince the leadership that rigid airships were a necessary part of national security strategies. He wrote to the Secretary of the Navy expressing concern for the growing British and Japanese rigid airship development plans. The British parliament had recently appropriated funding for the construction of two 5,000,000 cubic foot vessels and the reconditioning of two vessels of the size of *Los Angeles*. Japan was at the time negotiating contracts with the British to duplicate this program for themselves.[47] Moffett believed that both friends and foes would outflank the navy.

Moffett faced competition in his arguments from several sources, but none more notorious than the Assistant Director of the army's Air Service, Colonel Billy Mitchell. Mitchell, who had led the army's effort to steal the German war reparation airship from the navy, had persisted in his efforts to promote army aviation, and especially a separate air force.[48] In Congressional testimonies in 1924, Mitchell revealed the secret results of test-bombing runs of aircraft against an unfinished battleship, the *USS Washington*. Mitchell accused the navy of hiding the results of the experiment, and insisted that the success of the attack indicated the end of naval relevance. Through the use of propaganda events such as an around-the-world flight, Mitchell maintained the army's place on the front.

With the cancellation of the polar expedition, and the aviation crown threatened by Mitchell, Moffett searched for another way to publicize the *Shenandoah*. In consultation

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[47] General Board, "Rigid Airships and Appurtenances - Policy Regarding," 2.

with the commanding officer, he settled on a transnational publicity tour. For the navy, the voyage was intended to demonstrate the ability of the airship to land at untried locations. Germany had found during the war that the most danger to an airship is during the period of launching or landing. Rigid airships, while not fragile, were not designed to withstand impact with the ground. They were most often stored in sheds that protected them from the winds. Beginning with experiments on the R-38, and continuing with the *Shenandoah*, Fulton and the airship advocates of the U.S. Navy put considerable effort into mooring their airships to 'masts' that could be quickly erected to allow for operational flexibility. Henry Ford even erected a mast in Detroit Michigan. The airship advocates envisioned more private masts in the future and attempted to plan an airship mission to test Ford's.[49]

Shenandoah's transcontinental voyage in October 1924 kept her mooring exclusively on masts for 19 days. During this time Shenandoah and covered over 9,000 miles in all kinds of weather.[50] Her route was announced in advance to ensure that the most possible media coverage would be available. As a result thousands turned out at each location and the Navy Department received nearly 250 requests for the airship to travel to locations in the Midwest alone.[51] *Shenandoah*'s commanding officer was well aware of the publicity value of the voyage. He was authorized to make changes to the schedule, but

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[48]Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 152-153.

[49] "Findings of the Court of Inquiry Convened by the Secretary of the Navy to Inquire into the Facts and Circumstances Connected with the Loss of the Uss Shenandoah in Noble County, Ohio, September 3, 1925," (1925 Folder 4, Box 8, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC), 219.

[50] Garland Fulton, "Lighter-Than-Air Aircraft," (Folder 7, Box 6, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1931), 17.

[51] "Findings of the Court of Inquiry Convened by the Secretary of the Navy to Inquire into the Facts and Circumstances Connected with the Loss of the Uss Shenandoah in Noble County, Ohio, September 3, 1925," 218.

only while, “remembering, however, that this route will be published in the press and that many will be disappointed should the *Shenandoah* fail to follow the approved schedule.”[52]

In 1924 the second navy airship, the *USS Los Angeles,* was delivered from Germany to the Lakehurst base.[53] With *Los Angeles* came a team of a dozen Zeppelin Corporation airship engineers who would work for Goodyear Tire and Rubber Company in an attempt to transplant a working knowledge of airship design and construction to the United States. All became American citizens and formed what Fulton describes as, "the nucleus of the engineering staff of the Goodyear-Zeppelin Corporation."[54]

Because the *Los Angeles* was obtained as a part of war reparations, she was strictly limited to non-military uses. This was a challenging state for the navy’s airship program; however, the navy had always seen commercial airship development as an important part of its program. Also, the United States Navy had so little experience operating rigid airships that any training, even if it was not directly relevant to wartime operations, was seen as useful.

When the *Los Angeles* neared delivery, Fulton provided a study detailing three potential publicity tours in the United States, and suggested the transport of express mail as a means of providing funding.[55] Fulton assessed the three routes in terms of their

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[52] “Technical Aspects of the Loss of the Shenandoah” p. 687 cited in Robinson and Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935*, 104.

[53] The USS Los Angeles was completed in September, 1924 and flew from Germany to Lakehurst, arriving on October 15th. She was aided in her transit by the airship tender Patoka which provided weather reporting as she crossed the Atlantic.

[54] Fulton, "Brief Historical Outline of Rigid Airship Design," 12.

[55] "Prospective Uses Zr-3," (Folder 2, Box 9, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC).

meteorological feasibility, likelihood of providing income via passengers or mail, and value to the navy as publicity events.

One route sent the *Los Angeles* around the Southern edge of the country from Lakehurst to New Orleans and then on to Fort Worth, San Diego, Seattle, and Chicago before returning via New York. Fulton saw this as an excellent way of meeting the navy's publicity goals.[56] The *Los Angeles* was also intended to demonstrate the airship to potential investors.[57]

In late October 1924 the *Los Angeles* joined the *Shenandoah* in Lakehurst. Moffett carefully orchestrated her christening. The event was held in Washington DC, despite a lack of facilities, and the ship was christened by first lady Grace Coolidge.[58]

With the safe delivery of the *Los Angeles* and continued operations of the *Shenandoah*, 1924 was a hopeful year for the airship community. In addition to coordinating the safe delivery of the navy's newest airship, Fulton began designs for an entirely new type of airship, one of unparalleled size and range that had the capability to transport, launch, and recover airplanes within its infrastructure. Moffett's projections for 1925 included more work with the fleet, to include scouting, gunnery, refueling at sea, and possibly experiments hooking airplanes onto the new airships.[59]

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56 "Prospective Uses Zr-3," 2.

57 Robinson and Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935.*

58 The Los Angeles was seen as, "a symbol of peace and friendship" between the United States and Germany and was named as, "a harbinger of peace and a reminder of the angels who sang at the birth of Christ." "Washington Honors the Zr-3 Officers," *New York Times*, October 17 1924.

59 Annual Reports of the Navy Department for the Fiscal Year 1925 (Washington, DC: GPO, 1926) 613-616. Cited in Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 133.

The Challenge of Helium

Despite hopeful projections, the airship advocates still faced a major challenge. While German and all other foreign airships functioned using hydrogen as their lifting gas, the American airships were designed to use helium. First discovered in 1868 and first isolated in the laboratory in 1895, helium provides 92% of the lifting value of hydrogen. Its greatest benefit is that is not explosive. However, while hydrogen occurs naturally in the environment and can be “manufactured” at relatively low cost, helium at that time had to be gathered from helium-rich deposits of natural gas.

Fortunately, the world’s largest supply of helium-rich natural gas was found in the United States. Even by 1933 the United States was, “the only country in the world in which helium-bearing gases in amounts sufficient for helium production for aeronautical purposes have been found.”[60] In order to conceal its unique access to this natural treasure, the Department of the Navy and U.S. government began referring to helium by a code name, argon.

The navy, in cooperation with the army, undertook an experimental effort during the First World War to begin extraction of helium supplies in Texas. At a cost of $7,087,296, the project was eventually successful. By the end of the war, however, the mines had produced a mere 200,000 cubic feet of helium, enough for a fairly small airship.[61] Despite the challenges obtaining helium, its benefits drove the navy to adopt a helium-only policy for its airship program in 1922.[62] In order to supply this program and

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[60] Andrew Stewart, *United States Bureau of Mines Information Circular 6745: About Helium* (United States Bureau of Mines, 1933), 26.

[61] Jerome? Hunsaker, "Helium," (U.S. Naval Aviation History Center, Washington Navy Yard), 10.

[62] Hugh Allen, *The Story of the Airship (Non-Rigid)* (Akron, O. [Chicago: The Lakeside press, 1942), 67.

guard against nefarious use, the government established a National Helium Reserve in 1925 in Amarillo Texas. The Texas location had proven to be nearest the largest supply of helium-rich natural gas. The Reserve did not begin disbandment until 2005.

Although the country was fortunate in its strategic monopoly, processing helium for consumption by airships was still very costly. In 1922 helium cost $120.22 per thousand cubic feet while hydrogen cost a mere $2 to $3 per thousand cubic feet.[63] The high cost initially drove the General Board to suggest development of both hydrogen and helium airships. In its 1918 report, the Board proposes that the navy develop a, "hydrogen plant and build two hydrogen-using airships. . . [and] begin development of plans for construction of argon [helium] rigid airships, and build two of them." The report also notes that the navy should, "develop argon [helium] supply plants to meet future needs."

David Ingalls, Assistant Secretary of the Navy between 1929 and 1932 pointed out that the large airships run on non-flammable helium, and can continue to run even if up to 1/3 of the ship's gas cells are destroyed.[64]

Cy Caldwell, in his article for the May 1933 edition of Aero Digest magazine, expressed the frustrations and hopes of the advocates and the public. He pointed to the failure of the zeppelin as an offensive weapon of war, mostly due to the danger of hydrogen. He summed up, "the fact that the Graf Zeppelin is still in service does not obliterate my memory of dozens of other Zeppelins that have burned. Helium or nothing

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[63] Ventry and Koleâsnik, *Airship Saga: The History of Airships Seen through the Eyes of the Men Who Designed, Built, and Flew Them*, 143.

[64] David S. Ingalls, "Rigid Airships of the Navy," (Folder 4, Box 24, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1932).

is my motto"[65] For much of the public however, it seems the distinction between helium and hydrogen was somewhat lost. The airship advocates spoke repeatedly about the differences between helium-inflated airships and those filled with hydrogen.

Moffett wrote a twenty-page paper entitled, "Helium-Filled Rigid Airships are Safe"[66] Unfortunately, the paper begins with a rather depressing, "All pioneering on the land and sea, and now in the air, is strewn with wrecks."[67] Moffett goes on to reassure the reader that not only does helium make airship operation safe, but also that helium is well-supplied and available. "From reliable geological reports, it is well established that from one field alone twenty million cubic feet per annum of helium or more can be extracted for the next fifty years."[68] Moffett's predictions were significantly off the mark. The helium supply would continue to hamper airship operations throughout the history of the platform, and indeed naturally-supplied helium would remain a challenge until more efficient production methods allowed improved mining.

Despite Caldwell's and Moffett's enthusiasm, there was a belief among the airship advocates that hydrogen might effectively be used during wartime to improve performance of the rigid airships. With a better weight-carrying ability, hydrogen could allow for more

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65 Robinson and Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935*, 13.

66 William A. Moffett, "Helium Filled Rigid Airships Are Safe," (Folder 1, Box 22, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC).

67 Moffett, "Helium Filled Rigid Airships Are Safe," 1.

68 Moffett, "Helium Filled Rigid Airships Are Safe," 7.

nuanced be performance, especially in landing, and allow the airships to operate at a higher altitude ceiling.[69]

Airships Under Fire - 1925

If 1923 and 1924 were years of growth and optimism for the airship advocates, 1925 was a true turning point. *Shenandoah* spent the first half of the year laid up on Lakehurst, recovering from the transcontinental travel and allowing *Los Angeles* use limited helium resources. The *Shenandoah* was lost in an accident over Ohio in October of 1925. The airship program, in part through her loss, gained a new advocate, Charles E. Rosendahl. Even Moffett identified 1925 as a crucial stage of lighter-than-air development within the naval organization.[70]

On the larger world scale, 1925 represented a period of slowing in reference to national air policies.[71] Finally, 1925 saw the creation of a new type of airship. The 'metalclad,' was created by a group of Detroit inventors rather than the airship advocates, and was first demonstrated to Congress in 1925.[72] Airship historian Richard Smith calls the period of 1925-1926 a crisis in rigid airship development.[73]

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69 United States. Navy Dept. Bureau of Aeronautics., *Rigid Airship Manual* (Washington: Folder 2, Box 13, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC, 1927), IX-8.

70 General Board, "Rigid Airships and Appurtenances - Policy Regarding."

71 Fulton, "High Spots in the History of Rigid Airships in the Navy."

72 In the perspective of Fulton and Rosendahl, funding for the metalclad drew away funds for the large rigids. Congressional funding for the metalclad was made available in 1931. Fulton, "Brief Historical Outline of Rigid Airship Design," 17.

73 Smith, *The Airships Akron and Macon*. page?

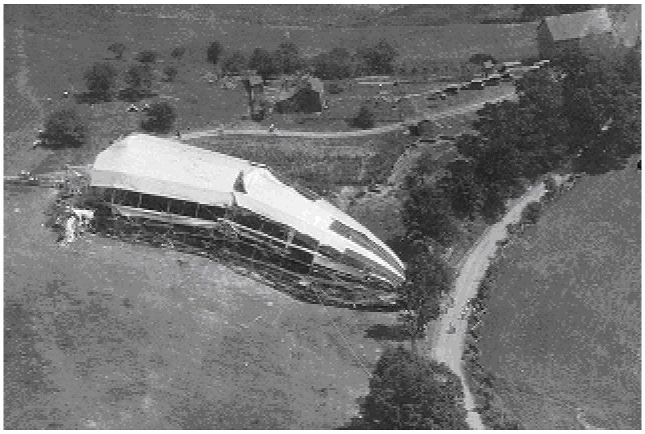

Table 6: Naval Historical Center Photo #NH98998 *USS Shenandoah*'s Wrecked Bow Section, September 1925.

The crisis began with the loss of the *Shenandoah*. After flying for less than two years the *USS Shenandoah* was lost in a storm on 2-3 September, 1925. The *Washington Post* claimed the accident occurred when, "after battling the elements for several hours, the huge aircraft suddenly shot upward to an altitude of approximately 7,500 feet from a 3,000 foot level, where the dirigible buckled amidship. The pressure and twisting was so great that it broke the ship into three sections."[74] Onboard, some, including the commanding officer, were stranded in the control cabin which crashed most heavily to ground. Two airship officers were able to pilot the tail section of the airship to ground more safely. A total of fourteen men onboard were killed.

In terms of loss of life, the accident could have been much worse. Some authors, such as airship historian Arthur Ventry, attribute this relatively high survival rate to the use of helium; the ship would have exploded in flames as she broke up if she had been using

[74] "Wrecked by Gale, Airship Plunges to Ground in Pieces," *Washington Post*, September 4 1925.

hydrogen.[75] At least one German author pointed out, however, that if the ship had been filled with hydrogen she might have been able to avoid or outmaneuver the storm that caused her crash.[76] Still, at the heart of the crash was a dangerous and sudden storm that the *Shenandoah* was not equipped to handle.

One of the officers onboard was Charles E. Rosendahl, who would become the second most public airship advocate. As navigator on the *Shenandoah*, Rosendahl was responsible for steering the ship. The *Shenandoah* required several adjustments in the watches that Rosendahl stood prior to the crash. The commanding officer, sighting a storm which had not been indicated on pre-departure weather reports, directed Rosendahl to steer around and over the clouds.[77]

Table 7: Naval Historical Center Photo #NH46108 LCDR Charles E. Rosendahl circa 1930.

75 Ventry and Koleâsnik, *Airship Saga: The History of Airships Seen through the Eyes of the Men Who Designed, Built, and Flew Them*, 143.

76 End of the Shenandoah, p. 2

77 "Findings of the Court of Inquiry Convened by the Secretary of the Navy to Inquire into the Facts and Circumstances Connected with the Loss of the Uss Shenandoah in Noble County, Ohio, September 3, 1925," 221-223.

While it seemed the storm had been avoided, the ship became caught in a violent vertical air flow. At times the rate of ascent exceeded two meters per second.[78] The pressure broke the airship into three sections. Rosendahl described the event to the press, saying, "There was a crash. I heard the struts breaking and saw the nose of the ship parting from the control compartment. A second later I heard another crash, which must have been the control ship hitting the ground. It was in this compartment that Commander Lansdowne [the commanding officer] and others were killed."[79]

The American public learned of Rosendahl through his reports to the press and his role in the navy's Court of Inquiry for the *Shenandoah* crash. The Secretary of the Navy's court of inquiry found that the deterioration of structural materials did not play a role in the airship's crash.[80] The airship was also fully and competently manned. The court described the loss of the airship as, "part of the price that must inevitably be paid in the development of any new and hazardous art."[81] On the whole, the court found there was no party specifically at fault for the accident, and did not find any fault in the design or construction of the airship.

The loss of the *Shenandoah* cost the navy more than just a training and experimentation platform. The accident, according to Rosendahl, also "caused the

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78 C. E. Rosendahl, "Loss of the Uss Shenandoah," ed. Secretary of the Navy (Lakehurst, NJ: 1925 Folder 4, Box 8, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC), 4.

79 "Wrecked by Gale, Airship Plunges to Ground in Pieces," 3.

80 "Findings of the Court of Inquiry Convened by the Secretary of the Navy to Inquire into the Facts and Circumstances Connected with the Loss of the Uss Shenandoah in Noble County, Ohio, September 3, 1925," 220.

81 "Findings of the Court of Inquiry Convened by the Secretary of the Navy to Inquire into the Facts and Circumstances Connected with the Loss of the Uss Shenandoah in Noble County, Ohio, September 3, 1925," 224.

abandonment of steps taken…to utilize the *Los Angeles* for commercial purposes"[82] Henry Ford, whose mast the *Shenandoah* was scheduled to test when the accident occurred, decided not to announce his intention to begin his own plans for commercial airship development as a result of the crash.[83] The *Washington Post* suggested that the crash might cause the navy to reverse its airship program, and even close the base at Lakehurst.[84] Within the public arena, there was already some skepticism as to the airship's future.

After even the Shenandoah was destroyed there was a sense among some that enough time had been allotted for the navy to determine the value of this type of vessel. *Mechanical Engineering* editors wrote, "two years' experience with the Shenandoah should have been sufficient to determine the value of such craft as an adjunct to the fleet, whilst the twelve months very active commission of the Los Angeles should have indicated whether the airship was likely to prove a successful commercial venture. As yet, the responsible authorities have ventured no public pronouncement on naval or commercial airships, although it has been recently announced that the closing of Lakehurst naval airship station is contemplated in next year's estimates."[85] Lakehurst did not close in the next year, but its tenure would not be long.

Following the accident, Rosendahl addressed most of his efforts toward promoting the airship to the American public at large, and reshaping the image of the airship program. He spoke on the radio and in print about the experience of traveling on an airship, allowing

82 Rosendahl, "Information on Ligher-Than-Air," 6.

83 Mingos, "Shenandoah Disaster a Costly Lesson to Aviation."

84 "Loss of Two Ships Expected to Force Change in Program," *Washington Post*, September 4 1925.

85 "Editorial for Mechanical Engineering," (Entry #160 Box 13; Record Group 72; National Archives Building, Washington, DC.: 1929), 860.

those who never would to feel the sensations of what was then called ‘aerostation.’ In one of his early Navy Day addresses, which was promulgated both on the radio and via newspaper, he walked the listener through the steps a commercial passenger would take getting onto the *Los Angeles*, from finding the hat rack and their assigned luggage locker to the scent of gourmet meals and their plush seating arrangements.[86] He portrayed the airship as the transport of luxury, emphasizing passenger comfort and ease of travel rather than the navy’s wartime uses for the craft.

After the accident Rosendahl went on to become commanding officer of the airships *Los Angeles* and *Akron*, as well as serving as an observer on the *Macon*. When the rigid airship program came to an end, he remained a faithful believer. Rosendahl wrote two full-length book manuscripts on his experience with naval rigid airships, both of which remain unpublished. He also wrote hundreds of articles, letters, and memos for many decades following the end of the official rigid airship program.

The crash of the *Shenandoah* gave opponents within the navy, and those without, further fuel for their arguments against the rigid airship. The *Shenandoah* was described as, “primarily an experiment,” and the accident seemed to some to prove that rigid airships were insufficiently developed for commercial use.[87] The *New York Times* suggested that, “The tragedy recalls the fate of others,” and provided a summary of airship losses dating back to 1912.[88]

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[86] One example of this type of speech can be found in Charles E. Rosendahl, "Radio Speech," (Folder AC 2/77-B43-F1; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1926).

[87] Mingos, "Shenandoah Disaster a Costly Lesson to Aviation."

[88] "Tragedy Recalls the Fate of Others," *New York Times*, September 4 1925.

However, perhaps the best-known statement on the *Shenandoah* disaster came from Colonel Billy Mitchell. Mitchell in a treasonous statement that would end in his court martial declared, “These accidents are the direct result of incompetency, criminal negligence, and almost treasonable administration by the War and Navy Departments.”[89] He suggested that the airship was not filled with sufficient helium, in an effort to cut costs. His statement was sufficiently inflammatory, illogical, and illegal to remove him from further aviation discussions.

As the airship came under fire, Moffett and Fulton also increased their roles in promoting the new platform both inside and outside the navy. Airship historian Richard Smith argues that, "From 1925 to his retirement in 1940, Fulton exerted a greater influence on the direction of the navy’s lighter-than-air aeronautics than any other individual not in a policy-making position."[90] Fulton's enthusiasm for the airship was based on its interest to him as an engineering feat. He spoke more often and more comfortably to technical civilian audiences, often addressing structural as well as commercial issues. In a speech to a group of engineers, he discussed the luxury that a passenger could expect, the challenge of selling the airship as the train and steamship were sold, and the likely reality of seasonal traffic.[91] He promoted the airship as a safe and comfortable means of transport, especially for trans-Atlantic travel.

Despite the differences in their audiences, Fulton and Rosendahl maintained a close friendship. Letters between them were friendly and casual. They wrote as often as weekly

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89 "Mitchell Charges 'Gross Negligence'," *New York Times (1857-Current file)* 1925.

90 Smith, *The Airships Akron and Macon*, 7.

91 Fulton, "Some Matters Relating to Large Airships," 12-13.

during some periods of their friendship, calling each other Froggy and Rosie.[92] Fulton asked Rosendahl to review his work, which Rosendahl did including providing technical details and insights into other players in the airship field. Rosendahl wrote of his frustration with the personnel system, and even discussed leaving the navy.[93] Rosendahl's letters to Fulton were frequently handwritten, commonly in pencil, and often many pages long.

1926-1928 Two More Will be Built

Between 1926 and 1928 the airship advocates struggled to maintain a place for airships both in the navy's strategic thinking, and in the imagination of the American public. Congress, however, had not lost faith in the airship. After the *Shenandoah* was lost, Congress made a full investigation of the airship situation and took inputs from the Morrow Board. In 1926 Congress decided to fund the construction of two large rigid airships.[94] A five-year aviation plan written by Moffett provided the outline for the Bill. Moffett, always aware of political nuance, described the plan as "a conservative and yet adequate plan, keeping in mind the necessity for economy urged by the President.[95]

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[92] See C. E. Rosendahl, ed. Garland Fulton (Folder 2, Box 11, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC)., and Garland Fulton, "Dear Rosie," (Folder AC 2/77-B109-F8; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1927).

[93] In Charles E. Rosendahl, "Dear Fulton Tuesday Pm," (Folder AC 2/77-B109-F8; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1927), 6. Rosendahl wrote to Fulton of his frustration with an organization that ignored the good ideas of its personnel and was generally relegated to a lesser position within the Navy.

[94] The Morrow Board, a Congressional investigation board called together by President College to investigate the problems of aviation in the United States, included high-ranking officials from the major aviation corporations of the time.

[95] Coletta, *American Secretaries of the Navy*, 617.

The bill, HR9690, was initiated by the House Naval Affairs Committee, where its members argued that, "the least that should be done in this effort is to provide for two rigid airships of approximately 6,000,000 cubic feet to be used as adjuncts to the fleet."[96] The two ships, which would eventually be christened the *Akron* and *Macon*, were based on designs produced by Fulton and the Bureau of Aeronautics in 1924. The decision for two airships was based in part on maximizing value; one airship could be built for $5,000,000 and the second would be only $3,000,000.

HR9690 is very comprehensive and gives a good picture of how both the navy and the Congress saw these new airships supporting the naval mission. It is worth citing in some detail:

> The committee finds that airships of adequate size hold unquestionable possibilities as adjuncts to the fleet. Large airships are peculiarly naval as their sphere of greatest usefulness lies over the water; they are essentially long-distance, weight-carrying machines, having long radii of action, superior habitability, the ability to operate at night successfully without the necessity for elaborate lighted airways, and wide range of speed variation to the extent of being able to stop all engines and remain aloft.
>
> Their principal naval mission will be scouting and reconnaissance, augmented by such uses as anti-submarine operations, convoy work, carrying airplanes, transportation of and communication with detached units, and, under certain conditions, bombing.
>
>> In the case of a large airship of proved type of construction, built so that interior parts are accessible for repair during flight; filled with non-inflammable helium gas; equipped with machine guns for defense or limited offense; and carrying two or more airplanes for self-protection, vulnerability will be reduced to a point where it will not militate against the airship playing an influential role in military operations. . .
>>
>> The committee feels that the least that should be done in this field is to provide for two rigid airships of approximately

[96] Rosendahl, "Information on Ligher-Than-Air," 7.

> 6,000,000 cubic feet volume each, to be used as adjuncts to the fleet."[97]

The bill came none too soon for the navy's airship program. A General Board study of 1926 highlighted the disparity in American airplane and airship development. The General Board estimated that the airship was, in 1926, where the airplane had been in 1916. With only $1 invested in airships to every $100 in airplanes, the Board indicated that the United States had no airship industry, and implied that it could only develop a viable airship industry through government investment.[98] HR9690 seemed to imply that Congress and the government were committed to developing a rigid airship capability and industry within the United States.

Passage of the bill was due at least in part to the vigorous efforts of the airship advocates. Fulton had been at work on the new airship designs for several years prior. Rosendahl took on the mission of publicizing the bill to the American public, and Moffett wrote to Congressional leaders to encourage their support.

The Congressional decision was also explicitly directed at building an American airship industry that could support commercial airship operations.[99] Identical plans and construction approaches would be used on the two craft. The new airships were significantly different from those that had gone before in two ways. In the first place, they were much larger than any American or German airships constructed previously. The concept was to create ships that could cross an ocean with a sufficient margin of lifting gas. As helium has only ninety-two percent of the lifting power of hydrogen, helium-based

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[97] What about the airship?, p. 15-16 from Senate committee on naval affairs report on 9690, dated May 17, 1926

[98] General Board, "Rigid Airships and Appurtenances - Policy Regarding," 2.

[99] Fulton, "High Spots in the History of Rigid Airships in the Navy."

ships would need to be larger.[100] This increased size would allow the new airships (which would be named *Akron* and *Macon*) to travel more than two and one-half times as far as *Los Angeles* without refueling.[101]

Additionally, the airships would each carry five F9C Sparrowhawk airplanes within their infrastructures. These small biplanes, already part of the navy's inventory, would be used to defend the airship as well as increase its scouting ratio. With the airplanes, the new airships would be able to scout 62,500 square nautical miles in five hours.[102] The ships would take two years to construct.[103] Design competitions for these two were held in 1927 and 1928.[104]

While the navy waited for the new airship contracts to be completed and signed, they had only the *Los Angeles* for training and demonstrating the airship's capabilities to the fleet. However, the *Los Angeles* was still bound by treaty agreement not to participate explicitly in military activities. Rosendahl, as the ship's commanding officer did his best to combine these incompatible goals.

Rosendahl's key objective was to keep *Los Angeles* in the air, for publicity trips, training, or even calibration of local radio stations. He argued that each mission provided training for his crew. As commanding officer Rosendahl put 284 hours in the air on the

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100 Technical studies revealed that the ships would need to be 6,000,000 cubic feet in order to achieve the desired range. General Board, "Rigid Airships and Appurtenances - Policy Regarding," 3.

101 Garland Fulton, "Airship Progress and Airship Problems," *Journal of the American Society of Naval Engineers* XLI, no. 1 (1929): 30.

102 Numbers derived from William McBride, "Technological Change and the U.S. Navy," in *MIT Program VIII - A Centennial* (2001). and "The Uses of Airships for the Navy," 1.

103 General Board, "Rigid Airships and Appurtenances - Policy Regarding," 3.

104 Fulton, "Brief Historical Outline of Rigid Airship Design," 15.

ship, nearly doubling her total air time.[105] The air time was certainly helpful to converting the American public, but it may not have been as relevant for the navy. Rosendahl, in a 1942 letter, suggested that, "one of the greatest mistakes we ever made was in not mooring the *Los Angeles* out and leaving her out during a complete year's cycle."[106] ‘Mooring the *Los Angeles* out’ referred to leaving the *Los Angeles* affixed only to masts, rather than keeping her in a shed. The mast method would be most useful to the navy as with the masts the airship could operate at some distance from her New Jersey base. The use of masts was also tested as a solution to what were described as the principal difficulties of the airships: landing, mooring, and ground handling.[107]

While Rosendahl tried to keep the *Los Angeles* in the public eye, Moffett tried to ameliorate the situation by acquisition. He suggested the construction of a small training airship that naval airshipmen could use while waiting the minimum two years for the new large rigid airships to be completed.[108] Moffett’s plan had certain logic. Not only would his airshipmen maintain their qualifications, but the navy could operate an airship that was actually designed for and employed in military operations.

Moffett's memo to the General Board makes the following recommendations:

> (a) Continue rigid airship development.
> (b) Adopt a program for new construction covering a period of five years. This program to include –
>
> > (1) Purchase of a training airship of about 1 1/4 million cu. ft. capacity, expecting delivery in 18 months.

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[105] Robinson and Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935*, 148.

[106] Charles E. Rosendahl, "Correspondence Mills-Rosendahl 1940," (Folder 3, Box 9, George Henry Mills Collection (Acc. 1994-0022). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1940), 1.

[107] Charles E. Rosendahl, "Aeronautics in the Navy," (Folder AC 2/77-B66-F3; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1929), 9.

[108] General Board, "Rigid Airships and Appurtenances - Policy Regarding," 3.

(2) Establish a shed base on the West Coast.

(3) Start design and construction of two, or at least one 6,000,000 cu. ft. airships, expecting their completion not before 1929.

(c) Parallel this construction program with an adequate personnel program.

(d) Maintain Lakehurst in operating status.

(e) Continue to co-operate in helium conservation, production; provide transport and storage.

(f) Give lighter-than-air activities a more definite place in budget plans. Approval of a program would automatically be a step toward this end.[109]

Despite Moffett's best efforts with the Congress, and Rosendahl's appeal to the American people, there was a sense among the airship advocates as early as 1927 that the airship's prospects were limited and threatened from within the navy. At this point, personnel issues seemed to be the central threat. Rosendahl wrote to Fulton in January of 1927 that, "with lighter-than-air prospects what they appear now, LTA should begin to prosper very soon or forever fade from the navy. . . In my opinion, however, it cannot proceed until we get our personnel matters once and for all on a sound basis."[110]

One of the greatest personnel challenges the organization faced was ensuring that there were sufficient airshipmen available to fly the new platforms. Difficulties centered on maintaining officer strength, and were apparent throughout the navy of that period. According to naval historian Gerald E. Wheeler, "Between 1921 and 1933, because attrition and officer input were almost in balance, there was very little overall growth in officer strength."[111]

Also, according to Bureau of Navigation ruling, officers were required to gain at least two years of 'sea duty,' to be eligible for promotion. Members of the aviation

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[109] General Board, "Rigid Airships and Appurtenances - Policy Regarding," 3-4.

[110] Rosendahl, "Dear Fulton Tuesday Pm," 4-5.

[111] Gerald E. Wheeler, *Admiral William Veazie Pratt, U.S. Navy: A Sailor's Life* (Washington: Naval History Division, Dept. of the Navy: for sale by the Supt. of Docs., U.S. Govt. Print. Off., 1974), 488.

community initially had difficulty convincing the Bureau of Navigation to give sea duty credit for service with aviation units.[112]

Fulton hoped that Moffett's personal attention would help solve the personnel problems. He wrote back to Rosendahl, "I think lighter-than-air is getting a reasonably square deal on personnel. If kicks from heavier-than-air organizations are any guide, lighter-than-air is getting more than its share. This is attributed by heavier-than-air organizations to the very deep personal interest Admiral Moffett takes in anything that relates to airships."[113]

The threat, according to Rosendahl, didn't always come from very far off in the navy organization. Writing to Fulton in 1927, Rosendahl sums up the situation by writing, "I am not going to continue any longer than necessary to be a member of an outfit that suffers ridicule, abuse, lack of cooperation, and lack of proper leadership. This ridicule, abuse and lack of consideration and cooperation comes not only from other parts of the service but just as much from our own aero. organization."[114]

While Rosendahl, Fulton, and Moffett attempted to maintain the airship program, contracting difficulties pushed the new giant rigid airships even further into the future. Goodyear-Zeppelin won the initial 1928 competition but funding difficulties required the Bureau of Aeronautics to go back to Congress. On 19 March 1928 President Coolidge

112 See Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 133-137.

113 Fulton, "Dear Rosie," 1.

114 Rosendahl, "Dear Fulton Tuesday Pm," 1-2.

weighed in, expressing his support for funding of metalclad airships rather than large rigid airships.[115]

While Congress and the White House sorted out these details, a competitor to Goodyear-Zeppelin submitted a proposal for the new airships and a second competition was held, further delaying construction. The result was that the contracts with Goodyear-Zeppelin, which did eventually win the competition again, were not signed until early October, 1928.

Work did not begin on the *Akron* until just over a year later. Moffett traveled to the construction hangar in *Akron*, Ohio, to drive a golden rivet into the main duralumin ring. As he did so, he declared, "Other nations have airships, and it has been well established that America cannot be without them. We want our country to be the first with this new merchant marine of the air, making seacoasts of inland cities."[116]

Conclusion: The Age of the Advocates

The airship advocates, Moffett, Fulton, and Rosendahl, closed 1929 with high hopes for the navy's airship program. One of the new airships was under construction; the other would soon follow.[117] Despite the losses of the R-38 and *Shenandoah*, the advocates saw the program as well on its way to fulfilling the promise of the airship. They turned their

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[115] For further discussion of the funding issues surrounding these decisions and William C. Young's role in the negotiations, see Richard K. Smith, "The Airships Akron and Macon: Flyng Aircraft Carriers of the U.S. Navy" (University of Chicago, 1965), 17.

[116] Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 232.

[117] Due to limited facilities, the airships had to be built one at a time; Macon would not begin construction until *Akron* was completed, in 1931.

efforts to promoting the airship in the public press, and planning for the operational future of the new airships.

Chapter 5: Deciding Against Airships (1926-1938)

While the advocates worked to sell the airship to the navy and the country, other forces and actors worked against this end. Like any new technology, the airship had to contend with existing and better-understood platforms. Within the navy, the airships also had to compete with budget issues.

This chapter examines the decision to end further investment in the airship. The decision was not singular, nor could it be attributed to one individual or organization. Several groups played a role, between 1926 and 1937, in ensuring that the navy would not acquire another airship. The groups that eventually ended the navy's airship program were not the same groups as were most relevant in the decision to invest in the airship. While there were several organizations that were important to the decision against airships, they did not work as part of a concerted or coordinated effort.

The General Board, operating navy, and Congress all had a part in the demise of the airship, as they did in the initial decision, however, their relative influence and importance had changed. Also, partially due to the efforts of Moffett and the other advocates, the American press played a very strong role in the decision not to invest further in airships. This chapter will trace the years between 1926 and 1937, when opposition to the navy's experiment with the rigid airship grew.

Hints of Decline - 1926-1929

Between 1926 and 1929, the airship advocates were still enthusiastically selling the airship to the American public, and Congress. There seemed to be cause for optimism as

Congress decided to fund two new airships for the navy, and operations with the fleet were being planned. In this period, however, signs of growing anti-airship sentiment can be seen in the work of the Navy's General Board.

The General Board was a major supporter of rigid airships between1913 and 1925. By the mid-1920s, however, the Board began to back away from its earlier enthusiasm for the platforms. Three major General Board studies demonstrate the changing perspective of the General Board on rigid airships.

In 1926 Curtis Dwight Wilbur, Secretary of the Navy, requested that the General Board consider inputs from Moffett and others and re-examine the naval aviation policy.[1] In his letter to the General Board, Moffett argued that the best way to further airship development was to construct a small training airship. This smaller airship could be employed while the navy waited for the two new vessels under construction. The General Board took Moffett's input, and developed a report that commented on the airship program as a whole.

The General Board's report, entitled 'Rigid Airships and Appurtenances,' was based on Moffett's and others' inputs, as well as comprehensive hearings.[2] Findings of the report can be summarized, "Operations of the *Shenandoah* if considered alone do not justify their existence as members of the fleet."[3] Further investment in the airship, the Board suggested, might even be, "detrimental to fleet needs."[4]

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1 Moffett's suggestions of (924 were past of the collection of documents the Gravened Bond was asked to consider. Moffett at that time had requested an additional training airship. The Secretary of the Navy suggested Moffett's request be reconsidered after Shenandoah had participated in some fleet problems.

2 General Board, "Rigid Airships and Appurtenances - Policy Regarding," 1.

3 Citations from General Board, "Rigid Airships and Appurtenances - Policy Regarding." and other sources can be found in Rosendahl, "Information on Ligher-Than-Air," 7.

4 Rosendahl, "Information on Ligher-Than-Air," 7.

The General Board then made recommendations as to future airship policy. On the whole, it recommended maintaining the navy's previous policy of completing existing airships. As the navy had just lost the *Shenandoah*, the Board suggested replacing the *Shenandoah* so the navy could carry out sufficient, "experiments to determine the value or lack of value of rigid lighter-than-air craft for military purposes."[5] Further, the Board insisted that any future airship (if built), embody essential military characteristics, implying that the purely-commercial *Los Angeles* was of limited value to the navy. As for the future, the Board's suggestion was that the navy "encourage and aid in every way practicable the commercial development of lighter-than-air craft."[6] By this statement the General Board made clear that it did not see a future for the rigid airship in military operations.

The General Board noted, however, that if there were any military future for the rigid airship it would be with the navy, rather than the army. On that basis, the Board argued that the navy should continue to test the development of this experimental craft, so long as it did not cut deeply into spending in other proven vessels such as battleships and airplanes.[7]

Moffett's view on the likely future of airships was more optimistic. He wrote to Secretary Wilbur, "While there are a good many airship critics, and while existing airships have been operating under numerous handicaps, nearly every one seems to agree that the *Shenandoah*'s work with the fleet and the *Los Angeles*' work, have been promising and that

[5] Rosendahl, "Information on Ligher-Than-Air," 7.

[6] Rosendahl, "Information on Ligher-Than-Air," 7.

[7] General Board, "Rigid Airships and Appurtenances - Policy Regarding," 2.

rigid airships should be further developed." Moffett cited in particular the long distance cruises of these two airships as proof of their value.[8]

On average, the civilian leadership of the navy, its Secretaries and assistant secretaries, were more supportive of the airship and aviation in general. This may be due to a decreased cultural affinity for the traditional platforms of the operating navy. Civilian naval leaders were also more concerned than military leaders with funding aspects of naval programs, and so may have presented a more positive view in order to sell programs to Congress.

The General Board's second study, submitted in l927, was in response to the report of the Taylor Board that was convened at the request of the Secretary of the Navy to consider the navy's aviation policy. [9] As a temporary organization made up of naval officers, the board represented an operational perspective. The Taylor Board's almost exclusive focus on heavier-than-air issues reflected the larger navy's lack of interest in lighter-than-air activities.

Reports from the Taylor Board introduced anti-submarine patrol as a mission for airplanes for the first time, and elevated 'scouting' to the third most important mission for heavier-than-air assets.[10] These recommended shifts in policy decreased the types of missions that had traditionally been associated with the airship. According to the Taylor Board, airships should be developed primarily for limited coastal patrol.[11] This type of

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[8] General Board, "Rigid Airships and Appurtenances - Policy Regarding," 2.

[9] Taylor Board consisted of: RADM M. M. Taylor, Rear Admiral W. A. Moffett, CAPT J. M. Reeves, CAPT H. V. Butler, CAPT James J. Raby, CAPT A. W. Marshall, CAPT Harry E. Yarnell, CDR T. G. Ellyson, LCDR M. A. Mitscher, member and recorder see Record of proceedings of Taylor Board

[10] General Board, "Report of Board to Consider and Recommend Upon Present Aeronautic Policy," 3.

[11] General Board, "Report of Board to Consider and Recommend Upon Present Aeronautic Policy," 2.

patrol would leave the airships operating from the shore, far from providing the 'support to the fleet' promised by Moffett.

The General Board response to these findings suggested that, "as regards lighter-than-air aircraft, only one large rigid aircraft would probably be operated. . . Consequently no additional housing facilities or personnel would be necessary."[12] The General Board also noted that non-rigid airships should be built only as may be necessary for training purposes.

Two Crashes -1929-1931

By 1929 the airship advocates seemed to have recovered from the loss of the *Shenandoah*. Despite the negative report of the General Board, Congress also approved plans for a second, West Coast airship base at Sunnyvale, California. The airship advocates were directly involved in the selection of Sunnyvale, with Moffett leading investigations into weather, cost, and strategic distances.[13] The second base was more carefully considered than the first base at Lakehurst and was the subject of several boards of inquiry. While both were close to the major coasts, Sunnyvale was also proximate to the fleet in San Diego. Significantly farther south than Lakehurst, Sunnyvale also promised better weather, a key challenge in maneuvering the airships in and out of their sheds.

On the international scene, 1929 was a year of great success as the Graf Zeppelin flew the first round-the-world flight, with Rosendahl onboard as a passenger. [14] The Graf Zeppelin, the most advanced commercial vessel of the Zeppelin corporation, had long been

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[12] General Board, "Report of Board to Consider and Recommend Upon Present Aeronautic Policy," 10.

[13] William A. Moffett, "Statement on Location of Airship Base," (Record Group 72 Entry #160 Box 33; National Archives Building, Washington, DC.).

the airship advocates' proof that commercial airships were a viable venture. The round-the-world flight received excellent media reporting and encouraged a fervor of interest in the American public.

More ominously for the rigid airship program, the stock market crashed in October. The stock market crash would initially cost the navy and hence the airship program funding. Roosevelt's initial efforts to balance the federal accounts caused the navy to implement a policy whereby most ships would be rotated to reserve status every third year. Congress eventually overturned this plan, which would have decreased the navy's operating budget by nearly 1/6. While the airships were not affected by this plan, the Bureau of Aeronautics still came under great funding pressure. Between 1929-1932 Moffett and the Bureau returned $7 million of appropriated funding to the government.[15]

While the airshipmen waited for the arrival of the new large rigids, the rest of the navy's aviation program was suffering personnel shortages. Heavier-than-air naval aviation personnel were so much in demand that it was impossible for many to undertake postgraduate work. Fulton pointed out in a memo that this was not be the case for stalled lighter-than-air personnel, as they waited the two years for the new airships[16]

During this time the navy's airshipmen also began experimentation with a new type of airship, called a metalclad. Carl B. Fritsche, airship engineer, designed the metalclad airship to respond to concerns about the vulnerability of the airship to anti-aircraft fire. At

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14 Charles E. Rosendahl, "Article for Popular Science Monthly," (Folder AC 2/77-B62-F9; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1929).

15 William A. Moffett, "Release for Morning Papers," (William Moffett Collection. Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1932), 3.

16 Garland Fulton, "Memo Subject: Post-Graduate Courses for Lighter-Than-Air Personnel," (Entry #160 Box 13; Record Group 72; National Archives Building, Washington, DC.: 1929), 1.

200,000 cubic feet, the metalclad was a miniature airship compared to the *Los Angeles* and *Shenandoah*. It was also significantly less expensive. The range of the metalclad, however, was very limited, making it impossible to operate at great distance from the shore or supply ships. The ZMC-2, pictured below, had a useful load capability of only 750lbs.

Table 8: *USS ZMC-2* at Naval Air Station Grosse-Ile, 1929. http://nasgi.org/zmc2.htm.

While the airshipmen had only the *Los Angeles* and ZMC-2 metalclad, the heavier-than-air faction of the navy sent their more than 700 airplanes to exercises, fleet problems, and practiced launching and landing on ships of the fleet.[17] Seaplanes, aircraft that could be launched from surface ships or the ocean surface, and then land on pontoons, were also part of the operating navy's fleet of the time. Among the airship advocates, the seaplane was not seen as a direct competitor to the airship. The seaplane had very limited range that prevented it from strategic scouting far out to sea, but this range increased throughout the age of the airship, making both the seaplane and airplane look like more viable competitors for airship missions.

[17] Rosendahl, "Aeronautics in the Navy," 6.

In the meantime, Rosendahl continued to sell the airship to the American public. The following is a portion of an article he wrote for *Popular Science Monthly* that draws on the romanticism of the airship:

> 'Stand by for 'Up Ship!' all the ropes except those permanently attached to the ship are cast off. In the control cabin the Engineer officer pulls over the indicator of the engine telegraphs to 'two engines ahead, half speed." A gong clangs in the motor gondolas. Compressed-air starters spin the motors. They fire. A stream of air shoots back past the elevators or 'flippers' that the elevator man is ready to raise, to force up the nose of the ship as soon as it is clear of the ground. The ground crew is tugging at the hand rails along the cars to hold back the throbbing ship. 'UP SHIP!' as hard and as fast as it can, the ground crew literally throws the ship high in the air. We go up nose first. 'All engines ahead, cruising!' signals the engine telegraphs. We're off!"[18]

Rosendahl also regaled his readers with exciting tales as part of his propaganda, telling of when the *Los Angeles* nearly had a run in with an airplane at night, and again how she was shot at, in the air, by an 'over-enthusiastic' New Jersey duck hunter.[19] Rosendahl appealed to the public through grand visions of the future as well, he looked as far out as 1950 in an article for *Modern Mechanics*, suggesting to his readers that the few 'pioneer ships' built by the navy allowed one to predict, with some accuracy, the future of the airship.[20] He predicted airships with a ceiling of over 20,000 feet, which could thereby avoid antiaircraft fire and combat airplanes from a position of strength.[21] Rosendahl also described a future airship that would carry machine guns and light artillery, and be immune to antiaircraft fire due to the use of helium.[22]

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18 Rosendahl, "Article for Popular Science Monthly," 3.

19 Rosendahl, "Article for Popular Science Monthly," 1-2.

20 Charles E. Rosendahl, "Airships," *Modern Mechanics* (1929): 1.

21 Rosendahl, "Airships," 2.

22 Rosendahl, "Airships," 1.

Despite the looming threat of budget challenges, 1929 was a successful year for airships. By December 1929 it was possible for an editorialist from *Mechanical Engineering* to write that, "public confidence in the practicability of this means of travel. . . has been restored by the successes of this year."[23] Of course the majority of this view was built on the success of the Graf Zeppelin, but the general feeling of goodwill associated with the airship was beneficial for the navy as well.

1930 passed with even fewer events for the American naval airship program. The Lakehurst crew operated the *Los Angeles*, conducting tests with airplanes in the formation that would be used with the *Akron* and *Macon*. In May the *Los Angeles* launched the first airplane from an airship. Airshipmen also tested the new metalclad airship, flying over cities in the East.[24] On one such voyage, airshipman Lieutenant Hammond Dugan caused a local sensation by dropping a note in a weighted bag from the ZMC-2 to his mother's doorstep.[25]

In addition to training missions, airships played a role in Naval War College wargames in 1930 for the first time. Although actual airships did not participate, they were simulated to act as airships might in a maritime conflict. One professor with knowledge of the games noted that, "the most striking fact brought out in this problem was the comparative immunity of a helium-filled ship when used as a scout even in an area of

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[23] "Editorial for Mechanical Engineering," 1.

[24] Rosendahl's sparse notes on the events of 1930 can be found in Rosendahl, "Information on Ligher-Than-Air," 9.

[25] "Report of Board Appointed at Request of Secretary of the Navy Swanson by the Science Advisory Board," (Box 1; Hammond Dugan Collection; Maryland Historical Society; Baltimore, Maryland: 1936).

enemy surface ship concentration. . . "[26] Unfortunately, the actual airships were not able to prove this insight with the operating navy.

Despite the success of the Graf Zeppelin, and the simulated airships in the Naval War College games, opposition to the airship grew between 1929 and 1931. Rosendahl, in his memo “The Opposition and How They Got that Way” identifies a small minority within the navy that were particularly anti-airship, but noted that their ability to create 'waves' within the navy department was important, because navy leadership would get a sense that the navy was anti-airship, but was unable to identify why or who.[27] It seems that the initial and central reason for operating navy opposition to the airship was competition for the navy dollar.[28] Especially as budgets tightened, operating navy leaders saw the airship as a threat to their own platforms and programs.

Among the oppositionists, Moffett biographer Trimble identifies, ‘entrenched conservatives’ led by Admiral Charles F. Hughes and Samuel S. Robison, both of whom were commanders in chief of the U.S. fleet, and other high ranking officers including Rear Admiral William R. Shoemaker and Richard H. Leigh of the Bureau of Navigation.[29] Beyond these particularly antagonistic few, four commanders-in-chief of the U.S. fleet in succession recommended against the use of lighter-than-aircraft in the fleet.[30]

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26 Naval War College Professor "Shifty", "Dear Rosendahl," (Folder AC AC 2/77-B140-F19; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1930), 2.

27 Charles E. Rosendahl, "The Opposition and How They Got That Way," (Folder AC 2/77-B44-F4; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1958), 2.

28 Rosendahl, "The Opposition and How They Got That Way," 2.

29 Admiral Hughes was also Chief of Naval Operations between 1927 and 1930. Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 7.

30 Rosendahl, "Information on Ligher-Than-Air," 7.

To Sea at Last - 1931-1935

Between 1923 and 1940 the U.S. Navy used a series of 'fleet problems' to explore and experiment with naval combat. Sequentially numbered, the annual fleet problems were the culminating event of the navy's training year. In addition to providing a lifelike training environment, the problems were used to develop new operational approaches and test new technologies. The twenty-one fleet problems conducted between 1923 and 1940, were, according to one Secretary of the Navy, "of the utmost value in training the fleet."[31] Between 1931 and 1935, when the rigid airships participated, they averaged twelve days in length. The objectives of the fleet problems were fairly constant:

- Train commanders in making estimates of the situation and plans;
- Train the fleet in large scale maneuvers
- Study war plans, operational instructions, and tactical doctrine.

The problems also served several secondary goals, including as a publicity venture for the navy as a whole. During the problems, Congressman, and members of the press were invited to see the navy's new capabilities. The platforms participating in the fleet problems also received high exposure within the operating navy.

1931 saw the first large-scale participation of the *Los Angeles* with the navy fleet. This was made possible as through negotiations, the Los Angeles was released from her treaty restrictions that limited her to civilian activities only. Los Angeles went to sea in February 1931 to participate in fleet problem XIII as a member of the Blue, or friendly

[31] Claude A. Swanson, Secretary of the Navy, in 1939.

force. These fleet problems focused on detection and attack of submarines using aircraft from aircraft carriers. [32]

While participating in the fleet problems, the airships were cut from their ashore commands and delegated to the Commander-in-Chief of the U.S. Fleet. Moffett describes "activities afloat" as the majority of operations conducted by the Bureau of Aeronautics.[33] This was the case for the Bureau's airplane and seaplane missions. For the airship portion of the Bureau, however, they were secondary to activities ashore such as the publicity missions and public-relations activities.

The civilian Assistant Secretary of the Navy wrote that he felt the Los Angeles had not been properly tested during the exercise.[34] The Los Angeles was not used in a scouting mission that was properly adapted to her capabilities, in all likelihood because the operating navy poorly understood these capabilities. Finally, the Assistant Secretary Ernest L. Jahncke wrote, "I am delighted with the results that were obtained. I feel that they support the Department's view that lighter-than-air will be of material value in our fleet operations."[35]

In stark contrast, the operating navy was much less impressed with the performance of the airship. The Commander-in-Chief of the U.S. Fleet, Admiral Jehu V. Chase noted, "I wish to register here my opposition to the proposed development of rigid dirigibles in the

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[32] Scot MacDonald, "Last of the Fleet Problems," *Naval Aviation News* (1962). See also Brian McCue, 2002, *Wotan's Workshop: Military Experiments Before the Second World War,* Occasional Paper, Center for Naval Analyses Occasional Paper, Alexandria, Va., October

[33] William A. Moffett, "Organization and Work of the Bureau of Aeronautics, U. S. Navy," *Congressional Digest* 4, no. 7 (1925).

[34] The Assistant Secretary argued that if the Los Angeles had turned and tried to outrun the planes that attacked her capabilities would have been better tested. She likely would have demonstrated the ability to outrun attackers. Rosendahl, "Information on Ligher-Than-Air," 20.

[35] Rosendahl, "Information on Ligher-Than-Air," 20.

navy."[36] Admiral Chase's opposition was directed at the high cost of the vehicles in comparison to their "probable usefulness."[37] He found the airship to be very vulnerable, and most perceptively noted that, "They have an appeal to the imagination that is not sustained by their military usefulness."[38]

Despite the opposition of the Commander-in-Chief of the U.S. Fleet, the navy acquired its long-awaited new airship in April of 1931. The *Akron* arrived a full five years after legislation was signed to ensure the delivery of the two new rigid airships. Moffett joined President and Mrs. Hoover and the President of the Goodyear-Zeppelin Corporation at the Washington DC-christening. In front of the crowd of 100,000 spectators Moffett drove a final, golden rivet into the airship. White doves, the National Anthem, and appropriate fanfare reflected Moffett's public relations touch.

Moffett's speech addressed the naval background of the new airship, noting that, "The Navy… has built this airship for naval purposes, and we will operate her as an adjunct to our surface and air fleets." However, Moffett's emphasis falls solidly on commercial, rather than military uses of the airships. He mentions that, "with them [the airships] passengers, freight, and mail can be transported from our inland cities to the cities of other countries across the ocean; from Akron, for example, to Berlin direct, or to Buenos Aires or Tokyo."[39] Each of these destinations was of course most interesting to commercial, rather than military, ventures.

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[36] Rosendahl, "Information on Ligher-Than-Air," 20.

[37] Rosendahl, "Information on Ligher-Than-Air," 20.

[38] Rosendahl, "Information on Ligher-Than-Air," 20.

[39] "Editorial," *New York Evening Post*, May 20 1931, 28.

The new airship was much larger than any that had ever been produced. His innovator's spirit, however, kept Moffett looking toward the future, and ever better and larger airships. He told the crowd at *Akron*'s christening, "if we are to retain our world leadership in all respects, our airships will have to be steadily increased in size until the limit is reached, whatever that limit may be. I would put it at about 10,000,000 cubic feet today."[40] There was even talk of expanding the size of the *Akron*'s sister ship, which had just begun construction.

The *Akron*'s first flight, with Rosendahl as commanding officer and Moffett and other dignitaries onboard, lasted over three hours. Moffett was thrilled when the airship made its successful landing, and proclaimed to the press that the *Akron* was "a great ship-the greatest ship of the air."[41] When *Akron* flew several months after her commissioning Moffett arranged for an NBC radio crew to broadcast commentary on the flight live. Millions of Americans listened in. Later in the same week, the *Akron* was used to fly 207 individuals, a record number of people in an aircraft.[42] The *Akron* appeared to be fulfilling the desires of the airship advocates to present a successful face to the navy's airship program.

Moffett confided to a friend, however, that he was not yet comfortable with the status of the rigid airship in the navy. "Putting over lighter-than-air has been the toughest job I ever undertook," he wrote. He also noted the challenge now posed by the General

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[40] "Editorial," 28.

[41] Philadelphia Special to The *New York Times*.Photo by Aero Service, "*Akron* in First Test; She Performs Well," *New York Times (1857-Current file)* 1931.

[42] For further discussion of the *Akron*'s early flights and their publicity value, see Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 256.

Board, which had become, "violently opposed" to the airship. Reflecting his methodical approach, Moffett noted that, "I will not breathe easily until the second ship and the Air Base at Sunnyvale, California, are well on their way. These are the marks that I have set for myself, and I will not be content unless they are accomplished."[43]

In a more public forum, Moffett was asked in June 1931 why he maintained faith in the airships despite the crashes of the R-38 and *Shenandoah*. He snapped back at his interviewer:

> Because I know that airships have a definite place in modern naval strategy and tactics. Because I know that they are the logical high-speed transoceanic commercial carriers of the future. Because we knew exactly what had happened to the R-38 and to the *Shenandoah*, and we were prepared to avoid such mishaps and mistakes in the future. Besides, we had in this country a monopoly on something which would be an enormous safety factor in airship experimentation and development - helium.[44]

Using the new airship, both Moffett and Rosendahl directed their energies toward fighting negative depictions of the airship in the American press. By late 1931, Moffett would write to Rosendahl, "Since the *Akron*'s flight numbers of newspapers in the country have editorially urged that the second ship be not built. I am doing all that I can to divert attention from the second ship."[45] Rosendahl also saw the dangers of the press. In writing to Moffett he noted that, "a radio broadcaster named Kaltenborn last night took a mean crack at lighter-than-air. . . I do not know what can be done about it but he and Lowell Thomas in their regular broadcasts are listened to by many people and it might be well to

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[43] Cited in Trimble, *Admiral William A. Moffett, Architect of Naval Aviation*, 238.

[44] Courtney, "Lighter Than Air," 19.

[45] William A. Moffett, "My Dear Rosendahl," (Folder AC 2/77-B43-F1; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1931), 1.

try to contact these two if possible."[46] Kaltenborn was a particularly influential radio commentator whose work was heard for over thirty years beginning in 1928.

Moffett made his views on press handling part of his discussions with senior leadership. In writing to Congressman LaGuardia in late 1931, he noted that, "without in any way criticising the *New York Sun*, I may remark that its editorial policies during the past several years have been distinctly opposed to airship development." Moffett tried to take action. He wrote, "to the editor and offered to make available to him any information he desired about airships, but the general anti-airship attitude of the newspaper still persists."[47]

While the airship finally went to sea, and Moffett and Rosendahl did battle with the press, the most junior of the airship advocates, George Mills, began his lighter-than-air career in 1931. He had graduated from the Naval Academy in 1914 and began his naval career in a series of junior officer assignments as an aide and communications officer. In June 1931 he was transferred to Naval Air Station Lakehurst where he began lighter-than-air instruction, including flights with the *USS Los Angeles*. His first lighter-than-air assignment was as a naval observer to the Graf Zeppelin, a German commercial airship that flew between Germany and South America. Following three round trips he returned to Lakehurst as an operations officer before being assigned to the *Akron*'s sister ship, the *Macon*.

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[46] Charles E. Rosendahl, "My Dear Admiral," (Folder AC 2/77-B118-F16; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1931), 1.

[47] William A. Moffett, "My Dear Congressman," (Folder AC 2/77-B118-F16; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1931), 1.

Mills went on to become the commanding officer of Lakehurst as it moved out of rigid airship operations and prepared to support the fleet with non-rigid airships in World War II. During the war he served as the commander of fleet (non-rigid) airships in the Atlantic and retired from the navy in 1949.

Perhaps due to the large amount of time he spent with the commercial Graf Zeppelin, Mills had an excellent understanding of commercial airships. Among the airship advocates, Mills represented the next generation. The advocates and others of their cohort trained him and Rosendahl and Fulton carefully watched his career. Mills kept up a strong friendship with Rosendahl throughout his life. Letters between the two were exchanged on a weekly basis.

In June 1932 Akron set off to participate in her second and last fleet problem. The *Akron* was also scheduled to participate in fleet problem XIII, in March of 1932 but had to cancel due to unscheduled repairs. During the June exercise, *Akron* did not take her own airplanes, "due to inexperience and troubles with hook-on device [to draw the airplanes into the airship's interior]."[48] Despite the absence of this vital capability, *Akron*, "demonstrated her ability to cover wide sea areas in a search for surface ships."[49]

The commander of the Scouting Fleet, to which *Akron* was assigned for the exercise noted that, "it is only fair to point out that even if destroyed the information she would obtain might conceivably well be at less cost to life and property than if a surface craft were lost obtaining similar information." The commander's praise was tempered with

[48] From comments of *Akron*'s commanding officer, in Rosendahl, "Information on Ligher-Than-Air," 22.

[49] From comments of the Commander of the Scouting Fleet, in Rosendahl, "Information on Ligher-Than-Air," 23.

the note that he, “does not feel justified in recommending further capital expenditures for additional lighter-than-air craft.”[50]

Akron’s absence from the March exercise, and her activities in the June exercise, drove Admiral Schofield, Chief observer of the exercise to note that,

> From my experience with the *Akron* I am confirmed in the view, which I have long held, that this type of aircraft is unsuitable for naval service for the following reasons:
> 1) Too costly when compared with probable service that can be rendered.
> 2) Too dependent on favorable weather conditions for scheduled operations.
> 3) Completely dependent upon hangar service for prolonged operations.
> 4) Impracticability of providing hangar service in probable areas where services would be required.
> 5) Excessive cost of ground facilities for the type.
> 6) Extreme vulnerability of the type to aircraft attack.[51]

Schofield was one of the confirmed airship opponents and would remain so through his tenure as Commander-in-Chief of the U.S. Fleet and Chief of Naval Operations. Schofield’s assessment reflects the three major concerns of the operating navy in regards to the rigid airship: cost, operational effectiveness, and ground handling.

Of these concerns, the advocates could have no effect on cost. They attempted to mitigate questions of operational effectiveness by participating in more fleet exercises. Fulton took on the challenge of improving ground handling, mostly through the development of mobile masts. Some were developed to work along specifically-designed railroads, which would save ground crews the difficult challenge of maneuvering the large airships into and out of their sheds. The masts, the advocates hoped, would allow the

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50 From comments of the Commander of the Scouting Fleet, in Rosendahl, "Information on Ligher-Than-Air," 23.

51 William D. Leahy, "Statement of Admiral Leahy for House Naval Affairs Committee on Building a Rigid Airship to Replace the Los Angeles," (Folder AC 2/77-B140-F63; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1937), 2-3.

airship to operate from areas that were less developed, increasing their operational flexibility.

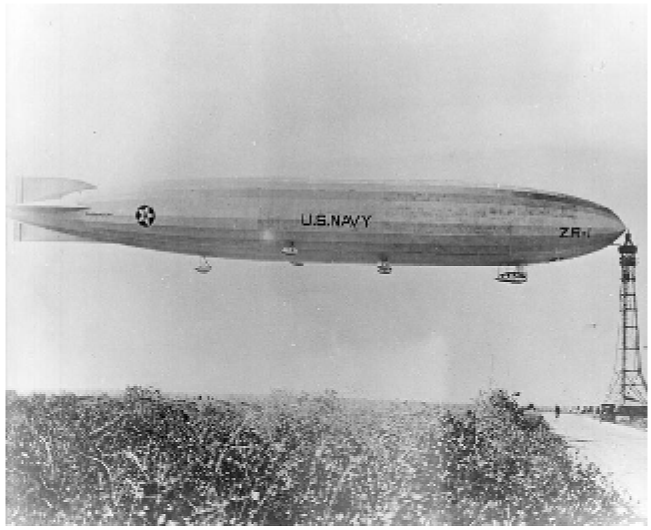

Table 9: High mast used by *USS Shenandoah* and *USS* Los Angeles, circa 1925. http://www.nlhs.com/highmast.htm.

Moffett felt that despite falling behind in other areas, by 1932 the U.S. Navy was 'leading unquestionably' in lighter-than-air.[52] He noted in a press release, "We have laid the foundation for a new industry and means of transportation; and hope, having done our part, that this country will create a merchant marine of the air in the near future that will take our flag and our commerce to all parts of the world."[53] The *Akron* participated in her first fleet support in January 1932. Mid-year, as *Akron* moved solidly into fleet exercises, the Los Angeles was decommissioned. Officially decommissioned for reasons of economy, the return to a single navy airship reflected the extremely limited helium supply.

[52] Moffett, "Release for Morning Papers," 6.

[53] Moffett, "Release for Morning Papers," 6.

Although the United States held a monopoly on the lifting gas, there was not enough produced in this period to keep two airships supplied simultaneously.[54] The *Los Angeles* had flown 4,200 hours, making her the most traveled of the navy's airships, despite her limitation to commercial activities.[55] *Los Angeles*' decommissioning took place only one year after the *Los Angeles* had been cleared for direct participation with the navy. In fact, she participated in only one exercise, operating only 27 days away from the Lakehurst hangar.

While the airshipmen began testing and training with *Akron*, Moffett reiterated his belief that commercial airships would soon become commonplace. He noted that the navy had no further construction plans. He looked forward to, "the passage of the McNary-Crosser bill in the Senate at the next session of Congress an airship of about 9,000,000 cubic feet will be built by commercial interests, the pioneer ship of a fleet that will continue this country's lead in airships."[56] Commercial support of rigid airships would never come.

A Tragic End - 1933

By 1933, Moffett was able to claim that the United States had unquestioned world leadership in airships, but he also recognized that the advocates had not done enough to demonstrate the value of the airship to the navy.[57] The year would see terrible losses for the program and the advocates.

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[54] Economizing of helium had always been a requirement of the airship program, however, with the *Akron* and soon Macon coming online, helium supplies were even more precious. The decision to decommission the Los Angeles was made mostly for reasons of helium conservation.

[55] Rosendahl, "Information on Ligher-Than-Air," 23.

[56] Moffett, "Release for Morning Papers," 7.

[57] William A. Moffett, "Address on Christening of Uss Macon," (Folder 4, Box 11, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1933), 2.

In part to respond to the navy's needs, Moffett and the Bureau of Aeronautics sought an East Coast base in a better climate that would present fewer challenges for launching and docking the large rigids. Accordingly, the *Akron* traveled to Florida, Cuba, and Panama, in March of 1933 in the hopes of finding an Eastern winter base. No decisions were finalized and the East Coast base remained at Lakehurst.

Halfway through 1933 the rigid airship program suffered its worst loss to date, with the death of Moffett and the destruction of the brand-new *Akron*. Flying near her New Jersey Hangar, in April 1933, the *Akron* encountered unexpected bad weather including wind gusts that pushed her, tail-first, into the Atlantic.[58] A Boatswain's Mate onboard described the crash; "It was five minutes past twelve when I laid down on my bunk in the outer keel. I happened to be looking up and noticed the No. 7 cell was swishing quite more than usual. While looking at this cell the ship gave a terrific lurch sideways and longitudinal girders 7 & 8 gave way as well as some of the wires. . . . About five or ten seconds before she crashed the lights went out in the keel. I . . . heard a noise aft and then water hit my feet. . . ."[59] The new airship *Akron* had been with the navy for only twenty months when she was destroyed.

Only three of the 78 men aboard survived, in part due to the crash in the cold waters.[60] President Roosevelt declared the accident a national disaster, and noted that, "the nation can ill-afford to lose such men as RADM Moffett."

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[58] The weather conditions were so poor that commercial heavier-than-air craft had been grounded.

[59] "*Akron* Aftermath," *Time* (1933).

[60] Life belts, due to their weight, were not included in the regular equipment of the *Akron*; the airship also had limited lifeboats.

Newspapers decried the disaster, calling for an end to the airship program as a whole. One paper ran a full page assembling articles from prior years that expressed their disapproval of the machines. The *Akron*, *Time* magazine suggested, “had been accepted as the answer to the stupendous list of airship casualties which had preceded it."[61] The ‘stupendous list’ included international crashes such as the R-38 and of course *Shenandoah*. In the press much was made of the last command issued on board the *Akron.* As the ship went down, survivors heard, “stand by to crash.” The Herald Miami of Florida ran a full-page "Imposing study of monarch of air which was death trap for seventy-five" while the city commissioner of Miami wrote to Carl Vinson to urge him to honor the lives lost in the Akron with government investment into a new airship.[62]

The crash led some to speculate on potential causes. Several years before the *Akron* incident, the members of the House naval affairs committee heard testimony from E.C. McDonald and W.B. Underwood (construction supervisor and mechanic on the *Akron* construction) swore that the ship had defective duralumin and hundreds of loose rivets. This was only one of the suggested mysteries surrounding the *Akron* crash. Another possible cause was that the ship had been mishandled, and broke only upon crashing into the water, rather than having been broken by a wind, which might indicate poor quality products. Also, the captain was heard to have said that his order to reroute the ship after the sighting of lightning was misunderstood, that the helmsman had adjusted by fifty rather than fifteen degrees.

61 "*Akron* Aftermath."

62 "Imposing Study of Monarch of Air Which Was Death Trap for 75," *Herald of Miami*, April 5 1933.

A Naval Court of Inquiry was held to examine the loss of the *Akron*. Broadly stated, its finding was that the commanding officer was guilty of an error in judgment regarding the weather at the time and how to handle his ship in the conditions given. The CNO declared that this finding was inconsistent, because insufficient information was known about why the commanding officer made the decisions he did, this information being lost with the ship.

Congress also conducted an inquiry and investigation into the, "cause or causes of the wreck of the Naval dirigible *Akron* and the wrecks of other army and navy dirigibles, to fix the responsibility for the same, to inquire generally into the question of the utility of dirigibles in the military and naval establishments, and to make recommendations to the Senate and to the House of Representatives with respect to the future use of dirigibles for military and naval purposes."[63] The findings of the investigation were surprisingly positive. During the investigation the committee heard testimony from, "fifty-six witnesses including an ex-Ambassador, an ex-Senator, Representatives, Generals, Professors, Doctors, outstanding editors, eminent specialists, aviators, outstanding figures in the aeronautical world, experts of every sort, non-so-experts, unbelievers, and the whole naval scale from bluejacket to Admiral."[64]

S. Fitz-Randolph and H. Phillips of *The Nation* journal had a more jaded view of the witnesses, argued that, "to be sure no lighter-than-air expert gave testimony negativing further dirigible construction, for today the only experts of this type in the United States are in the navy or with some commercial firm promoting airship construction." Fitz-Randolph

[63]Charles E. Rosendahl, "The Loss of the *Akron*, Draft for Publication in Liberty Magazine," (Box 1; Hammond Dugan Collection; Maryland Historical Society; Baltimore, Maryland: 1933), 11.

and Phillips conclude, "if the dirigible must run to cover at the sight of every cloud, it is difficult to see its practical value."[65]

The Congressional committee, however, saw in the navy's airship program, "further potential utility to be developed only by experience."[66] Eight of the ten members of the committee approved the following recommendations:[67]

> A) The navy to continue in the maintenance, development and operation of airships.
> B) Lakehurst Naval Air Station to be the center of training and a center of experiment; experienced personnel and necessary equipment to be provided there. Administration of lighter-than-air to insure continuity of personnel and experience. Impediments to promotion of naval officers should not be caused by their having specialized in the navigation of aircraft.
> C) A training ship to be built promptly. A new airship to be built to replace the AKRON, embodying such new developments as experience may show to be desirable.
> D) Meantime, the *Los Angeles* to be put back into commission for training and research pending completion of a new training ship.
> E) Four general weather maps per diem to be issued by the weather bureau instead of the present two.[68]

Rosendahl's perspective on the accident, expressed to Fulton, was that, "Boiled down, the judgment of a number of persons on a number of features, proved, by the results, to have been faulty. Again it was the "human equation."…There certainly was no 'culpable' or criminal intent – our best judgment simply was not good enough."[69] Publicly, Rosendahl wrote that, "[the argument] that 'weather' was an important contributing factor is

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[64] Rosendahl, "The Loss of the *Akron*," 11.

[65] S. Fitz-Randolph and H. Phillips, "Airing the Airship," *The Nation* (1933).

[66] "Bill of Health," *Time* (1933): 1.

[67] The committee involved five Senators, from Utah, Massachusetts, Wisconsin, California, and New Jersey, and five Representatives from New York, South Carolina, Ohio, Massachusetts, and Kansas.

[68] Rosendahl, "The Loss of the *Akron*," 11.

[69] Rosendahl, 7.

undeniable. But the *Akron* was destroyed primarily by terrific forward impact with the sea."[70] The manner of the loss of the airship was of less relevance than the loss of Moffett onboard.

Following the loss of Moffett, Admiral Ernest Joseph King took over as Chief of the Bureau of Aeronautics. King, according to one historian, was "not a skilled bureaucrat." His main interest was not in airships, or even heavier-than air assets, but in using the Bureau position as a stepping stone to promotion.[71] During his tenure, tension over personnel and management issues increased. In terms of airship management, however, King would ensure that the sole remaining airship, the *Macon*, spent more time with the operating navy.

The Macon carries on - 1933-1935

The same month that the *Akron* crashed, her sister ship, the *Macon* took her first flight. *Macon* was a near-identical copy of *Akron*, measuring 780 feet. She had improved engines, and was slightly lighter, however. These factors combined made her able to fly at 74, rather than *Akron*'s 70 knots. The christening ceremony, held just before *Akron*'s crash, was not nearly as elaborate as for *Akron*. Moffett and the advocates arranged for Moffett's wife to loose forty-eight white pigeons and christen the airship.[72]

The leadership of the Operating navy was not optimistic about the new airship. Admiral R.H. Leigh second in command of the U.S. Fleet, reported that, "While lighter-than-aircraft have uses not available in heavier-than-aircraft, the vulnerability, the high cost

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[70] Charles E. Rosendahl, "What Really Happened to the *Akron*?" *Liberty* (1933): 6.

[71] King was successful in his maneuverings. He became Chief of Naval Operations in 1942 following successful sea duty.

[72] "Macon Aweigh," *Time* (1933).

and the doubtful dependence that can be placed upon this type in a desired operation do not seem to justify their inclusion in a building program except for experimental purposes."[73] With this negative initial impression, *Macon* prepared for six months of fleet exercises.[74]

Macon joined the Battle Fleet on the Pacific coast in mid-October 1933, "with the great responsibility of selling airships to the fleet as long-range scouts."[75] After the loss of the *Shenandoah* and *Akron*, it seemed likely that whatever her performance, the fleet was already decided against the airship. During the exercises, *Macon* was to be tested against several fleet-assigned tasks. The exercises, however, were basically tactical in nature, and not a single one involved strategic scouting, *Macon*'s explicit strength. Five tasks were tactical scouting, and five others involved area search, one was of weather reporting, something any other craft could have done.[76]

Macon was given no particular assignments during the fleet exercises of October 1933. Rather than designing specific assignments to evaluate her capabilities, she was merely added to a series of previously planned exercises. Rosendahl would argue that the fleet exercises were not sufficient to prove the airship's capabilities. A true exercise would have put the airship into a strategic scouting environment, where she would have to locate and report on an enemy ship or fleet while evading enemy fire.[77]

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73 Leahy, "Statement of Admiral Leahy for House Naval Affairs Committee on Building a Rigid Airship to Replace the Los Angeles," 3.

74 Charles E. Rosendahl, "Statement of Lcdr Rosendahl before the Federal Aviation Commission," (Folder 30, Box 11, George Henry Mills Collection (Acc. 1994-0022). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1934), 9.

75 Charles E. Rosendahl, "On Trial," (Folder AC 2/77-B43-F1; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1959), 1.

76 Rosendahl, "On Trial," 5.

77 Rosendahl, "On Trial," 2.

Mills described the exercises in his "Assignment of Rigid Airships to the fleet," noting that, "despite the generally understood mission of the rigid airship [long-range or strategic scouting], the *Macon* while assigned to aircraft Battle Force had judgment passed upon her usefulness, finding her wanting as a Combat-Scouting unit (the use to which she was most generally put) without once operating on a mission for which she is ideally suited.[78] During fleet problems, Mills suggests that experienced officers were not always available to advise those in command of airship squadrons. Without this expertise, the airships were more likely to be misused.[79]

As major events in the navy's calendar, the fleet problems were under the scrutiny not only of the navy, but also the American public. Mills tried to sway several audiences on *Macon*'s performance in the exercises. To one group he noted, "Frequently you have seen in the press that the MACON has been shot down [during fleet exercises]. Did you know, or see in the press, that in these same engagements that battleships, cruisers, aircraft carriers, planes, destroyers, supply ships, and submarines, had been destroyed?. . . Unfortunately this kind of publicity has hurt the progress of airships."[80] Indeed, in some fleet problems *Macon* actually outperformed the more traditional Naval platforms.

Macon participated in six exercises with the Battle Fleet in 1933, but due to reconstitution, she represented a total of 13 rigid airships. The records of the fate of each of the 13 reconstituted airships is shown below:

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[78] George H. Mills, "Assignment of Rigid Airships to the Fleet," (Folder 39, Box 10, George Henry Mills Collection (Acc. 1994-0022). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1934), 3.

[79] Mills, "Assignment of Rigid Airships to the Fleet," 5.

[80] George H. Mills, "Talk before 20-30 Club of San Jose, California "Lta Situation 1935"," (Folder 18, Box 21, George Henry Mills Collection (Acc. 1994-0022). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1935), 9.

Result	Number of airships	Percentage of total airships
Destroyed by gunfire	3	23%
Damaged by gunfire	1	8%
Destroyed by airplane attack	4	31%
Unharmed	5	38%[81]

Table 10: Results of airship participation in 1933 naval exercises.

Looking across all of the thirteen participation opportunities, we can see that *Macon* had a record of sixty-two percent casualties, and thirty-eight percent unscathed.[82]

This measure is particularly interesting when compared with the rate of casualties among other major types of naval assets. Below is a summary of the casualty rates of other platforms performing in the 1933 exercise series.[83] The rigid airship thus fell into reasonable casualty range, when held in comparison with other naval assets.

Asset type	Percentage destroyed	Percentage damaged	Percentage unharmed
Surface craft	43%	19%	38%
Airplanes	76%	0	24%
All types	66%	6%	28%

Table 11: Results of airship and other platform participation in 1933 naval exercises.

[81] Rosendahl, "On Trial," 11.

[82] Rosendahl, "On Trial," 11.

[83] Rosendahl, "On Trial," 12.

In addition to inappropriate tasking, *Macon* labored under other imposed limitations. The commanding officer, according to Rosendahl, seemed 'clearly obsessed' with the idea of safeguarding the safety of the *Macon*, as the entire future of airships depended on prevention of physical harm to this ship.[84] Caution on the part of the crew, while understandable given recent crashes, did not fit with the navy's spirit of test and evaluation during the fleet problems. Also, *Macon*'s operators were limited by an order that restricted her onboard airplanes to operating only within 25 miles of surface craft.[85] This range did not allow *Macon*'s airplanes to perform their primary mission of increasing the visibility range of the fleet.

Despite these artificialities, the results of the airship experience in the fleet problems were used directly in the formulation of future naval aviation policy. In his report from the 1933 fleet exercises, the *Macon*'s commanding officer included umpire reports and observations of staff. This report was forwarded to the CNO. The operating navy's fleet command also submitted his own report to the CNO. The CNO forwarded the fleet command report to the Secretary of the Navy who passed it to the General Board. The General Board was asked to consider this report when making recommendations for navy airship policy.[86]

The operational fleet commander's report, according to Rosendahl, was "sharply critical of the *Macon*'s operations in the subject exercises." The report was, "particularly pervaded by one basic fallacy: it presumed to judge all rigid airships from the performance

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[84] Rosendahl, "On Trial," 3.

[85] Rosendahl, "On Trial," 9-10.

[86] Rosendahl, "On Trial," 2.

of one such craft-only the third one we had ever built, in the hands of only one commanding officer, on only six exercises and these of highly disputable suitability, spread over a period of six months, and involving only some 345 hours spent by the airship in the exercises." Rosendahl pointed out that, "In one exercise, the airship participated only half an hour." It does seem unlikely that any other military asset was subject to such limited evidence and opportunity. Rosendahl concludes, "In essence, the fleet command presented "the evidence," interpreted it in its own way, found the accused unworthy of further existence, and recommended capital punishment, from which the prospects of reprieve were extremely remote."[87]

For their part, leaders in the operating navy felt the fleet exercises of 1933 to be sufficient proof of the airship's value. Admiral J. M. Reeves in August 1934 expressed the following opinion, which is worth citing in detail:

> "At one time I had high hopes for lighter-than-air. I had visions of coordinating lighter-than-air with HTA as an integral part of the fleet. Those hopes have not developed, and I do not see any prospects, considering the limitation of LTA. I see no prospect that they can ever form an integral part of the fleet and maneuver and operate with the fleet. . . I am afraid the LTA is a very slender reed for the commander to lean upon for any purpose whatever, --intelligence work, scouting or anything else. It is too much affected by conditions of weather and other things.

[87] Rosendahl, "On Trial," 3.

> If the commander attempts to use LTA in any campaign he would never be justified without covering the same area, paralleling everything he called on the LTA to do, with some other ships he could control and upon which he could depend. He would never be justified in relying alone on the lighter than air doing a thing, because the certainty of its doing a thing doesn't exist. That gives a general view of what I most regretfully am forced to give as my opinion as to the possibility of LTA. The LTA may prove of some use patrolling from a coast. It may again have that fortunate coincidence of seeing something that is important, but if it ever sights an enemy combatant unit it will have ceased its value right then and there because I think it will cease to exist if it makes just that one report. It may never even make that report. If you consider the money that is invested in LTA, and that the same amount of money may be put into other things, I think it is a very long gamble in the LTA compared with the same value in other units.[88]

Macon actually made her first long-range scouting attempt months after her participation in the fleet problems.[89] In mid-July 1934, *Macon* set out from the California base to find President Roosevelt's two-cruiser complement which was at sea in the Pacific. The location of the ships had not been revealed to the public or the *Macon* crew. *Macon* located the ships within 26 hours of takeoff and delivered evening newspapers to the President who complimented the crew on their performance.

Even this apparent success worked against the airship program, however. The operating navy, learning of this feat only from front-page newspaper reports the next day, called the flight 'ill-timed, and inadvisable' and the result of 'misapplied initiative on the

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[88] Admiral Reeves was cited by Admiral Leahy in Leahy, "Statement of Admiral Leahy for House Naval Affairs Committee on Building a Rigid Airship to Replace the Los Angeles," 4-5.

[89] Rosendahl, "On Trial," 6.

part of the *Macon*'s commanding officer. Rosendahl, however, commends the officer on his foresight in taking advantage of this opportunity.[90]

Mills supported Rosendahls' perspective, arguing that, "the ideas of fleet officers of the ship's vulnerability have been due generally to inexperienced operation of the ship. It cannot be expected that personnel will learn in six months operation with the fleet all the qualities which the airship possesses."[91]

Outside the operating navy, however, there was continued optimism for the airship. Cy Caldwell, a journalist for *Aero Digest* in 1933, argued that the navy should continue to build. He wrote, "Not enough zeppelins yet have been built and operated to determine with any certainty whether the rigid airship is any good or no good. . . Where would today's transportation business in airplanes, railroad trains and steamships be if we had built only 140 airplanes, locomotives and steamships? If we had stopped at the 140th airplane, locomotive or steamship, people would have been justified in saying that so far as we then had gone our experiments with airplanes, locomotives and steamships had been failures."[92]

Enough Folly? - 1935-1938

The real firestorm in the media, however, began following the crash of the *Macon* in 1935. *Macon* was lost in conditions similar to that of the *Akron*. More than one paper ran blaring headlines. A full-page article in *New York Sun* following the *Macon* crash exclaimed, "And now the *Macon*! - Have we stood enough folly?" The paper then assembled articles in opposition to the airship program dating back to the 1925 crash of the

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[90] Rosendahl, "On Trial," 7.

[91] George H. Mills, "Naval Uses of Rigid Airships," (Folder 39, Box 10, George Henry Mills Collection (Acc. 1994-0022). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1934), 9.

Shenandoah. Ironically, the crash of the *Macon* seemed to propel the rigid airship issue into the civilian press in a way that Moffett could not despite years of effort. Not all the articles were negative. Authors in the U.S. Naval Academy's Trident and the National Aeronautic Association Magazine disputed over 'The Airship and the navy,' 'Airships Overcoming Setbacks' and 'Is the American Airship Dead?' [93]

In terms of official naval studies, the General Board contributed a final opinion on the airship question in 1937. The 1937 report dealt with two major aspects of the airship question, commercial and military employment of airships.

In terms of commercial use, the report noted that the large rigid airship had, "good possibilities for profitable commercial operations," providing, "comparative safety, carrying capacity, speed and comfort." [94] The role of the navy in this commercial development was clear. Since the navy possessed the majority of the ground equipment and, "practically all of the experienced operating personnel of the nation," commercial development would have to proceed with the assistance of the navy. It was, in fact, "the navy's duty to assist such development."

By pushing for commercial development of the airships, the General Board was not in fact trying to remove the military airship capability from the country. Their perspective was that commercial airships could be, "designed and built with a view to employment in

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[92] Robinson and Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935*, 13.

[93] J.J. Daub, "The Airship and the Navy," *United States Naval Academy Trident* (1935-36). "Airships Overcoming Setbacks," *National Aeronautic Association Magazine* (1935). F.D. Buckley, "Is the American Airship Dead?" *United States Naval Academy Trident* (1935-36).

[94] General Board, "Policy Relative to Lighter Than Air Ships Serial # 1732," (Folder AC 2/77-B140-F63; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1937), 12-13.

war." This arrangement, which was in place for surface ships, would also allow the navy to participate at a moderate level in the funding of commercial airship development.

The study's assessment of the military operational employment of large rigid airships was less favorable. The General Board echoed operating navy concerns over vulnerability of the airships, arguing that their vulnerability, "in the vicinity of considerable enemy forces is so great as to make the probable value of such use incommensurate with the probable cost." [95] Worse, the General Board suggested that airships might put surface ships at risk by revealing their presence to enemy forces.

The only optimism in the 1937 General Board report came in the field of the plane-carrying airship like the *Akron* and *Macon*, that the Board suggested are, "not yet sufficiently tested but which offers decided possibilities for usefulness in war, commensurate with the risk and cost. Immediate expenditures should be limited to exploration toward the determination of the value of this development."[96]

In summary, the General Board suggested that, "…expenditure of funds allocated to national defense is not warranted for large airships which are to be used in direct action, for scouting or for combat, or in close proximity to own fleet."[97] However, the Board allowed some leeway, noting that, "a definite cessation of all development work with the lighter-than-air is not warranted, nor is it sufficient that such work should continue using only the present equipment and material. Progress must be made in the field of establishing airworthiness and capacity for long-distance operations; in developing

[95] Board, "Policy Relative to Lighter Than Air Ships Serial # 1732," 9.

[96] Board, "Policy Relative to Lighter Than Air Ships Serial # 1732," 9.

[97] Board, "Policy Relative to Lighter Than Air Ships Serial # 1732," 9.

airmanship; reliability and security in cruising; in effecting landings; and in basing on a mast for extended periods."[98]

Finally, the Board recommended the navy's policy relative to lighter-than-air ships should be: "to build and maintain non-rigid airships in numbers and classes adequate for coastal patrol and other essential naval purposes…to explore the possibilities of developing rigid airships to meet naval requirements, to cooperate with other agencies in developing large commercial airships and to continue personnel training."[99] The personnel were to be trained to operate commercial airships that might temporarily join the fleet in wartime.

In addition to taking inputs from the General Board, the Secretary of the Navy appointed a temporary board, the Durand committee, to investigate the *Macon* disaster.[100] The Durand Committee was charged with conducting an inquiry, "of the broadest scope relating to airships (dirigibles) in general, whether for military (naval) or for commercial purposes."[101] Accordingly, the Durand committee went beyond a simple assessment of the *Macon* disaster, and addressed design and construction of a safe and useful airship and made recommendations as to future construction plans. The committee found that three conditions had changed since the designs of 1928 to create a more favorable environment:

1) Increased airship flying experience.
2) Improved mechanical engineering processes

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[98] Board, "Policy Relative to Lighter Than Air Ships Serial # 1732," 7.

[99] Board, "Policy Relative to Lighter Than Air Ships Serial # 1732," 14.

[100] Members of this committee: AV de Forest, William Hovgaard, Frank B. Jewett, TH. V. Karman, Charles F. Kettering, R. A. Millikan, Stephen Timoshenko, W. F. Durand, Chairman.

[101] Special Committee on Airships, "Report No. 1: General Review of Conditions Affecting Airship Design and Construction with Recommendations as to Future Policy," (Folder 2, Box 23, Garland Fulton Collection (Acc. XXXX-0101). Archives Division, National Air and Space Museum, Smithsonian Institution, Washington DC: 1936), 1.

3) Superior understanding of aerodynamic loads, and meteorology.[102]

The committee noted in particular that weather prediction had experienced, "revolutionary changes in the technique of accurate forecasting." that would allow for more safe and predictable airship travel. [103] On the whole, the Durand committee's report was extremely favorable toward the airship. The members pointed out that the country's experience with rigid airships, "has not as yet been sufficient to give ground for a wholly settled opinion as to the character and extent of their potential usefulness, either commercial or naval." To mitigate this situation the committee went on to recommend a 'continuing program of construction and use'[104]

Following the Durand Committee's favorable report, Congressional efforts on behalf of the rigid airship increased, spurred largely by the Naval Affairs Committee. Seven bills introduced between February 1936 and August 1937 addressed the acquisition of a metalclad airship, and airship use in the army and Coast Guard.[105] Together the bills reflect congressional optimism for the rigid airship, although with a greater focus on commercial airships and airships operated in support ashore, rather than at sea commands.

The most important Congressional decision for the rigid airship program in this period came in 1938. In that year, led by the House Naval Affairs Committee, Congress authorized the construction of a naval airship to replace the *Los Angeles*, with available funding reaching $3,000,000. The National Advisory Council on Aviation commented

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102 Special Committee on Airships, "Report No. 1: General Review of Conditions Affecting Airship Design and Construction with Recommendations as to Future Policy."

103 "Report of Board Appointed at Request of Secretary of the Navy Swanson by the Science Advisory Board."

104 "Report of Board Appointed at Request of Secretary of the Navy Swanson by the Science Advisory Board."

105 The bills were HR11397, HR1569, HR5530, HR7213, HR8289, HR8290, HR8291.

with satisfaction on this plan that allowed for the construction of an airship of some kind, albeit smaller than the rigids of earlier times.

The operating navy never acted on the Congressional authorization. According to Goodyear President Paul W. Litchfield, "no action was taken on this authorization because of a difference of official opinion as to the size of the new airship."[106] In fact, the operating navy had long since turned against the airship.

The ghost of the potential future airship would haunt the remaining airship advocates for decades. In 1940 former Bureau of Aeronautics Chief ADM King and Fulton together wrote a report at the request of Secretary of the Navy Charles Edison that called for immediate construction of the ship that had been authorized in 1938.[107] Even into the 1960s, Rosendahl would use this authorization as part of his public arguments for re-instigation of the navy's rigid airship program.

Why Didn't the Airship Fail Sooner?

Historical accounts of the U.S. Navy's rigid airship experience often point to the role of accidents in the failure of the new platform. More recent works, such as McBride's *Technological Change in the United States Navy*, written in 2000, assess the relevance of issues such as funding, personalities, and public perceptions in the decision to discontinue the airship program, rather than the emphasis on accidents.[108] A more interesting question, however, is why the rigid airship didn't fail sooner; why did Congress, the operating navy,

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[106] P. W. Litchfield and Hugh Allen, *Why? Why Has America No Rigid Airships? A Study of the Characteristics of Large Ocean-Crossing Rigid Airships, Leading up to the Question, Why Does Not American Use All Three, the Dirigible, the Airplane and the Steamship, to Provide This Country with the Best Possible Transportation System?* ([Cleveland: Corday & Gross co., 1945), 130.

[107] Litchfield and Allen, *Why? Why Has America No Rigid Airships? A Study of the Characteristics of Large Ocean-Crossing Rigid Airships, Leading up to the Question, Why Does Not American Use All Three, the Dirigible, the Airplane and the Steamship, to Provide This Country with the Best Possible Transportation System?* 131-132.

[108] McBride, "Technological Change and the U.S. Navy."

and the American public accept continued investment and effort in a system that appears from today's vantage point to be doomed to failure. And why did the airship advocates themselves maintain their faith in the platform?

There are certainly a variety of reasons for the continued enthusiasm for and investment in the rigid airship. The most relevant reasons for the continued development of the rigid airship can be attributed to the bureaucratic environment, the ambiguity of apparent technical difficulties, and the apparent commercial potential of the airships.

The airships, as with all innovations, were developed in a particular bureaucratic environment defined by leadership, funding, and organizational approach. In the case of the airships, each of these factors played a role in furthering airship enthusiasm and interest.

The rigid airships were well-supported within the naval and national leadership levels. The airship program found particular support from the civilian arm of the navy. Assistant Secretary of the Navy David Ingalls suggested in 1932 that,

> In fulfilling her mission of scouting the rigid airship can cruise for days, and for thousands of miles, affording through radio communication information of inestimable value to the Navy. Granted a visibility of twenty miles on either side of the airship, which is traveling at a rate of say sixty knots, during thirteen hours daylight, the total area covered would be over thirty thousand square miles. A cruiser with fifteen miles visibility, thirty knots speed, and thirteen hours daylight could cover only about one-third the area.[109]

In addition to support from naval leaders, although not among the operating forces, the airship drew support from other bodies within the government. In his "Status of Airship Development" Rosendahl compiles a list of independent governmental

[109] Ingalls, "Rigid Airships of the Navy."

organizations that lent support to the development of the rigid airship. Among the most important:

- National Advisory Committee for Aeronautics
- House Naval Affairs Committee that in 1925 re-authorized the *Akron* and *Macon*
- Chairman of U.S. Shipping Board Bureau
- The Sixty-Ninth Congress that authorized 2 naval airships
- Committee on interstate and foreign commerce of the seventy-first congress-which signed the merchant airship bill
- Joint Committee of the House and Senate to investigate the *Akron* disaster which recommended in 1933 that two new naval airships be constructed
- The Interdepartmental Advisory Committee on Aeronautics
- Assistant Secretary of Commerce
- Federal Aviation Commission
- Special Committee on Airships of the Science Advisory Board (Durand committee)

The navy of this period was also a navy in which new platforms were constantly under experimentation. New technological concepts were developed with great rapidity, and the exploration of a variety of options in a given platform was common. Between 1913 and 1921 alone seven different classes of dreadnought battleship were laid down under the auspices of the Bureau of Ships.[110] As airplanes went through similar evolutions of development, there was an expectation that new platforms would have to be explored and experimented upon.

This experimentation was particularly necessary as it was not entirely evident at the beginning of the tenure of the rigid airship that the airplane would ever develop capabilities to match those of the rigid airship. Indeed, in questions of sustainability and consistent presence, the airplane has not to this day.

Development of the airship also continued because the reasons for individual airship failures were somewhat ambiguous. Theodore von Karman, a nationally-recognized aeronautical engineer and contributor to airship design noted in his memoirs,

> After the *Macon* incident, many people, including President Roosevelt, became dubious about the worth of airships. The situation had changed overnight. Unlike the *Akron* incident, which was regarded as unavoidable, the *Macon*'s demise could not be easily explained. Even the naval Court of Inquiry, convened to determine the causes of the accident, could not readily point to a clearcut explanation. The *Macon* had been in duty condition. The commander handled the ship well. The ship had been designed by the best available talent, and all the normal forces likely to act on the structures were calculated on rational principles. . . yet the *Macon* had joined the long list of lost airships.[111]

Finally, airship development was buoyed by the promise of commercial potential. Commercial interests were willing to invest greatly in a platform that they saw as a potential answer to ferrying passengers between continents, a new attraction which remained far out of the range of capabilities of the airplane of the time. One such

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[110] Silverstone, *The New Navy, 1883-1922*, 12-16.

[111] Theodore Von Kármán and Lee Edson, *The Wind and Beyond; Theodore Von Kármán, Pioneer in Aviation and Pathfinder in Space*, [1st ed. (Boston: Little, 1967), 164-165.

commercial investor was Daniel Guggenheim, a mining industrialist. Guggenheim established a fund of $2,500,000 for the promotion of aeronautics. The fund allowed the city of Akron to develop an Airship Institute with expertise drawn from the California Institute of Technology. Garland Fulton and others published articles in the organization's publication, the Guggenheim Airship Institute Journal.[112]

Throughout the development of the airship commercial opportunities remained an alluring draw. The airship, some claimed, could also be used in peacetime for operations such as, "passenger use, mail delivery. . . photographic surveys of unexplored lands. . . [and] police runs on raiding tribes to, "bring the hardiest savages to their knees."[113] Commercial airship use, which was in fact more extensive than military use, had also resulted in a better safety record. One scholar of the period noted that the accident record for commercial airships was, "very much better, all things considered, than that of the airplane. Not a single life has been lost, as the Commander [Rosendahl] told you, in commercial navigation of airships."[114]

Conclusion

The period between 1926 and 1938 highlights the end of the rigid airship program in the United States Navy. During this time three rigid airships, *Shenandoah*, *Akron*, and *Macon* crashed. In each case, the advocates lost trained airshipmen and a measure of faith among the naval leadership. With each loss, the media response also became more

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112 Garland Fulton, "Current Airship Problems," in *The Daniel Guggenheim Airship Institute Publication #1*, ed. Theodore von Karman (1933).

113 Hareh, "The Case for the Airship; Extract from Aeronautics Magazine," 6.

114 Herbert Chase, "Rosendahl Advocates More Rigid Airships," *Metrosection Accelerator of the Society of Automotive Engineers*, May 1935, 2.

negative and far-reaching. With the loss of *Akron* they lost their key supporter, Admiral Moffett.

Within the operating navy, the first hints of growing anti-airship sentiment can be seen at the publication of the 1926 General Board report, Rigid Airships and Appurtenances. At the time, the General Board turned to reflect more closely the concerns of the operating navy. Additionally, the General Board's influence was fading, so that the airship advocates lost their initial and strongest supporter within the navy. From hints of disillusionment in the General Board's report of 1926, opposition grew within the navy and in the American public, despite successful airship participation in the fleet exercises and problems.

Despite these signs, the airship advocates remained optimistic, even after the death of Admiral Moffett. They continued to write about the airship and lobby in Washington DC for resumption of the program. The Bureau of Aeronautics continued its development efforts aimed at designing the next generation of airships. The largest of the proposed new designs was a nearly nine hundred foot-long rigid called the ZRCV. This airship was to carry up to nine dive-bombers within its superstructure. However, while the Bureau was continuing work on new designs, President Roosevelt intervened, forbidding the construction of any airship that exceeded three hundred and twenty-five feet in length. There was no hope of constructing an airship this small that could also carry airplanes, which were by then considered a necessity to ensure the military value of an airship.[115]

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[115] Martin L. Levitt, "The United States Navy and Lighter-Than-Air Aviation" (Temple University, 1991), 136-137.

The Durand committee report found promise in the airships, and Congress had appropriated funding for a new airship. However, among the group that was most relevant to this decision, the operating navy, all faith in the platform had been lost. The operating navy would not accept another airship in its inventory, even as Congress appropriated the funding.

Chapter 6: The Airship and Innovation Theories

This chapter will address the relationship between the story of the airship advocates of Chapters 3-5 and the innovation models discussed in Chapter 2. We proposed in Chapter 2 that models of successful innovation from different academic fields might be applied to the airship case to better understand failed innovation. Among the theories addressed in that chapter, those associated with military innovation, sociological innovation, and the systems/historical approach are the most applicable to the airship case. In the following pages we will address each of these three types. In each case, we will examine specifics of the airship history and how they apply to each theory.

Airships and the Military Innovation models

As discussed in Chapter two, military innovation models are a distinct and limited literature in comparison with business and sociological innovation. Like these latter, however, military innovation literature tends to focus on successful cases. Many famous military innovation studies focus on the period between World War I and World War II. Seminal works by Murray and Millet and Rosen have defined the military innovation literature.[116] In this section we will highlight how the airship fulfilled models of successful innovation promised by Murray/Millet/Rosen and a separate innovation measure provided by Susan Douglas.

In their Challenge of Change, Harold Winton and David Mets provide a useful summary of the Murray/Millet/Rosen model of successful innovation. According to these authors, in order to successfully innovate, military organizations must:

1. Determine a generally accurate picture of the nature of future war.
2. Determine the operational concepts that will most likely bring victory in this future environment
3. Translate operational concepts into guiding doctrine
4. Test experimental organizations to employ prototype equipment and/or new methods.[117]

Most of these factors were in place or under development during the age of the airship, however, with varying degrees of successful application. We will address each point separately and in order.

The first requirement, determining an accurate picture of the nature of future war, fell to the navy's General Board. War Plan Orange, developed by members of the navy's General Board and the army, can be seen as a relatively accurate portrayal of future strategic situations. The plan was used throughout the navy and larger military during the period of the rigid airship. The General Board knew that a certain amount of scouting and amphibious capability would be required for any potential war with Japan. The General Board's vision of future war involved a forward-deployed navy that would keep combat far from American shores. It became clear that sea power and naval bases, of the type described by Mahan, could best be supported and defended with the types of capabilities promised by aviation.[118] Airships were seen as particularly useful, especially plane-carrying airships such as the *Akron* and *Macon*, whose range allowed them to cross oceans.

Operational concepts, the second feature of successful military innovation, were developed by the Naval War College. During the interwar period, Naval War College wargames helped shape strategy and thinking regarding employment of new technologies.

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[116] Stephen Rosen, "New Ways of War: Understanding Military Innovation," *International Security* 13, no. 1 (1988). Murray and Millett, *Military Innovation in the Interwar Period.*

[117] Winton and Mets, *The Challenge of Change: Military Institutions and New Realities, 1918-1941*, xiii-xiv.

Operational concepts developed by the Naval War College were also the subject of experimentation during the annual fleet problems. Although the navy of this period had a process for the development and testing of operational concepts, the rigid airships were absent from both planning and experimentation.

In fact, airships were little known or understood at the Naval War College where operational concepts were developed. One former airship officer, writing from his new position at the Naval War College noted that, "the war college while it has lots of literature on Aviation in general, has little on Airships and has not made much study of them."[119] In fact, there is evidence that the level of misinformation about airships at the Naval War College was extensive indeed. Lieutenant Forrest Percival Sherman wrote a memo that was apparently shared within the Naval War College community before finding its way to Rosendahl. The memo argued that the airship was an "obsolete and discredited weapon by 1917." Lieutenant Sherman's memo was answered by a lengthy and scathing letter from Rosendahl correcting him on what was a memo that, "really merits only utter disregard." Rosendahl sent a copy of his response that ran five pages and addressed each of Sherman's points individually, to Admiral Moffett.[120] The rhetoric did little, however, to educate the Naval War College on the new airship technology and how it could be integrated into planning.

The requirement to translate operational concepts into doctrine is perhaps the least evident in the airship case. Between the world wars strategic doctrine had not yet become

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[118]Louis Morton, "War Plan Orange: Evolution of a Strategy," *World Politics* 11, no. 2 (1959): 250.

[119] Naval War College Professor "Shifty", "Dear Rosendahl," 1.

the strategic shaping mechanism that it would later become for the navy. The focus in this period was on developing amphibious tactical doctrine in support of War Plan Orange, and tactical doctrine for the new aircraft carriers.[121] Aerial spotting of surface targets, a mission for the new aviation assets, was developed in support of these doctrines. In terms of airship doctrine, there was little development in airship employment with the fleet. Initial efforts focused on standardizing equipment and procedures onboard airships. We can, however, observe some of the hints of doctrine development in the creation of an official lighter-than-air training program. In deciding on coursework, content, timelines, and required operational experience, the advocates were in fact creating airship doctrine. Rosendahl did much of this work, with some assistance from Moffett.

The airship clearly fulfills the demand for new organizations to further innovation. Two new organizations were relevant to the development of the airship, the Bureau of Aeronautics for the technical and acquisition issues, and the Scouting Fleet as a new operational organization. One of the challenges that these new organizations faced was how to obtain proper credit for their sailors and officers in terms of their naval careers. Traditionally, naval personnel have been required to complete a certain amount of 'sea duty' in order to qualify for promotion. The airship advocates, and Rosendahl in particular, put significant effort into obtaining an equivalent measure for airship personnel. In 1940 Rosendahl confirmed that he had been able to put 28 enlisted men on blimps to count as sea

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120 Forrest Percival Sherman, "Naval War College: Naval Airships," (Folder AC 2/77-B140-F21; Charles E. Rosendahl Lighter-than-Air Collection; McDermott Library; University of Texas at Dallas: 1927).

121 Trent Hone, "The Evolution of Fleet Tactical Doctrine in the U.S. Navy, 1922-1941," *The Journal of Military History* 67, no. 4 (2003).

duty, so long as they remained on that duty at least 12 months.[122] Also, having an organization is good, but the other half of Moffett's bureau was so successful it may have drawn focus any from the airship.

Establishing an airshipmen's career path also made it easier for operating navy to set the air shipmen aside as non-navy, a problem Moffett did not work to combat "The question of securing and retaining the necessary skilled personnel for airship operations, now and in the future is vital."[123]

Additionally, because the Bureau of Aeronautics combined lighter-than-air with a chief technological competitor, heavier-than-air, the organizational benefits were somewhat lost. Writing to Fulton in 1927, Rosendahl sums up the situation by writing, "I am not going to continue any longer than necessary to be a member of an outfit that suffers ridicule, abuse, lack of cooperation, and lack of proper leadership. This ridicule, abuse and lack of consideration and cooperation comes not only from other parts of the service but just as much from our own aero. organization."[124]

. In an article in the *Naval Institute's Proceedings*, Rosendahl wrote, "It is an erroneous impression that personnel who cannot achieve heavier-than-air designation or who can no longer fulfill such requirements can fall back into an easier situation and achieve a lighter-than-air designation."[125] Clearly the airshipmen were beginning to fall prey to negative perceptions within the operating navy.

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122 Rosendahl, "Correspondence Mills-Rosendahl 1940."

123 General Board, "Rigid Airships and Appurtenances - Policy Regarding," 2.

124 Rosendahl, "Dear Fulton Tuesday Pm," 1-2.

125 Charles E. Rosendahl, "Airship Personnel," *United States Naval Institute Proceedings* 35, no. 4: 3.

Using the same approach as Rosen, Douglas develops several indicators of what military organizations need to do in order to integrate new technologies. Specifically, the technology must be managed by individuals sufficiently high up in the organization to ensure its maximum exploitation. Also, there may need to be a position of relative independence and authority created for a technically and organizationally savvy individual to oversee and evaluate the performance of the new technology. Finally, once the technology is adopted, the organization must participate in and support innovations to it.[126]

Moffett, as a captain and then admiral, represented nearly the highest levels of the navy's leadership. By means of the Bureau of Aeronautics, and facilitated by his personal connections within the navy, he was afforded great leeway in directing the rigid airship program. The operating navy, once invited, participated to the degree possible in the development of innovations to the rigid airship. Unfortunately, this participation didn't begin until the *Akron* joined in the fleet exercises in 1932.

Airships and the Sociology of Innovation models

Of the social constructivist models examined in this study, the work of Wiebe Bijker, of the University of Maastricht, is the most relevant to the airship case. Bijker's social model, detailed in chapter two, graphically portrays the relationship between technologies, social groups, and the problems they share. Drawing on Bijker's work, Figure 1 illustrates a social innovation map of the navy's first airships, *Shenandoah* and *Los Angeles*.

Social groups, shown in rectangles, approach the technology from a shared perspective or 'technological frame.' The General Board, for example, saw the first airships as experiments, designed to allow the navy and the country to explore the potential for lighter-

[126] Douglas, "Technological Innovation and Organizational Change: The Navy's Adoption of Radio, 1899-1919," 171.

than-air. For the American public, the airships were symbols of the new technological era, and American dominance following the First World War. Each social group also brings its own set of problems – issues with the technology or challenges the group faces.

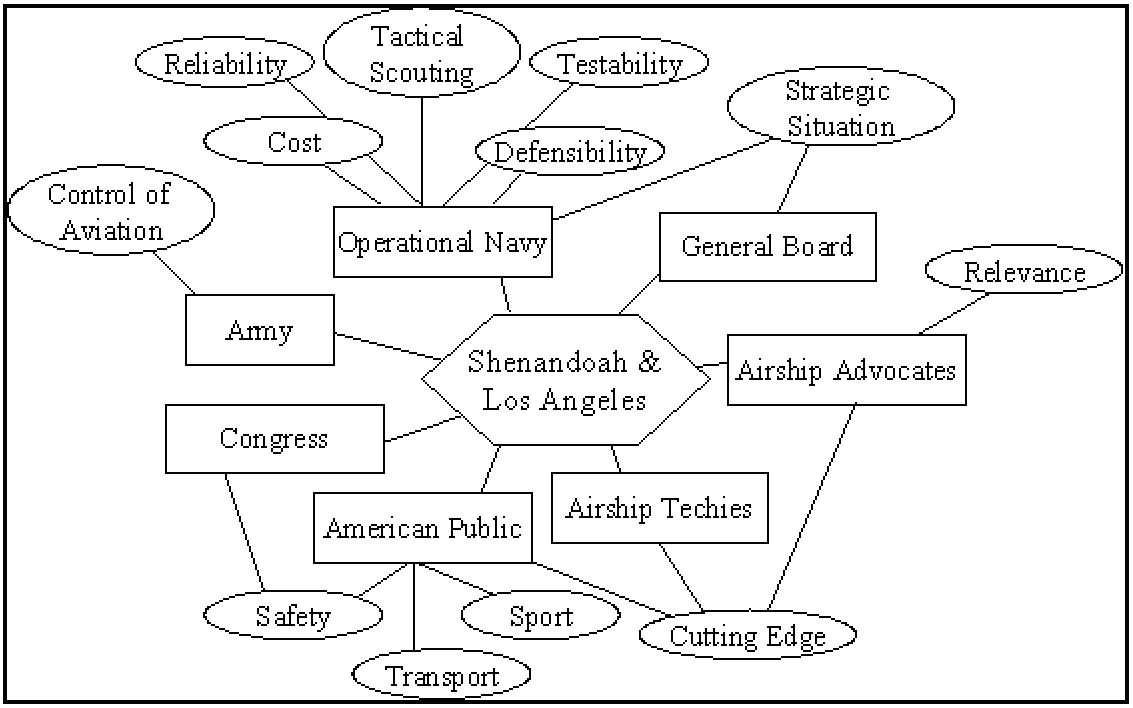

Table 12: Bijker's Social Theory applied to the airship case.

Problems, shown in ovals in the figure below, can be common to two or more social groups. Safety of the airships, for example, was a most pertinent issue for Congress and the American public. The operating navy also had a clear concern for the safety of the vessels, but this was included in broader concerns about reliability. An airship with poor safety ratings, or an inability for whatever reason to operate in the regional time or place required was of little use to the navy. Several individuals within the operating navy, however, expressed the belief that safety risk is inherent in the development of new technologies.

The airship advocates, concerned with their relevance in the larger navy, focused new innovations in airship technology on the needs of a few social groups, to the detriment of others. Hughes suggests that this is a common response when several social groups are involved in the shaping of a given technology. In this example, Congress weighed into technological decisions by providing funding, the General Board through strategic guidance, and the operating navy through employment. Moffett directed his efforts at the General Board, Congress, and the American public. This emphasis can be seen in his writings regarding controlling the American press, and in his plans for missions for the airships.

More than one historian has found the roots of the rigid airship's failure in Moffett's flair for publicity.[127] Historian William Althoff summarizes the problem as Moffett's, "regrettable penchant for publicity, which compromised acceptance of the rigid airship scout by the fleet."[128] By others he is described as, "a politician and a showman…" whose activities "hindered the airship's acceptance into the fleet. [He] emphasized public relations flights, which led many officers to dismiss the airships as 'show' boats of little value"[129]

Rosendahl was at least equally focused on the American public. By speeches and press releases, Rosendahl used rhetoric and imagery to play into the public appeal of the airship as a symbol of power and cutting-edge technology. Most of Fulton's public work by contrast was directed at fellow airship technicians, whether in the navy or commercial

[127] See McBride, "Technological Change and the U.S. Navy," 187.

[128] Althoff, *Sky Ships: A History of the Airship in the United States Navy*, 80.

[129] McBride, "Technological Change and the U.S. Navy," 187.

business. Mills, joining the airship movement rather late, and from a junior position, found it easiest to focus his efforts within the airship community of the navy. Among the advocates, none were directly concerned with the perspectives and problems of the operating navy.

Across the group of advocates, then, there was little emphasis on understanding the technological frame of the operating navy. The focus on publicity missions over operations with the fleet made it difficult for the advocates to understand and respond to the concerns of the operating navy. In part, this focus reflected the nature of the airships available. For nearly the entire 12-year history of the airship in the navy, the navy had only one operational airship. For six of these years, the navy's only rigid airship was the treaty-limited *Los Angeles*. Journalist W. B. Courtney even argued that the crash of the *Shenandoah* was the unfortunate result of the 'country fair' spirit of American politicians that put her over the inland country where she wasn't meant to be. He argued that *Shenandoah*'s place was on the ocean.[130] Rosendahl furthered this perspective in a testimony before Federal Aviation Commission. He noted that due to restrictions of non-military use of the *Los Angeles*, presence of fleet in the Pacific (combined with basing the airships in the Atlantic area), and other startup issues, there had been little interaction between the airships and the fleet by 1934.[131]

[130] Courtney, "Lighter Than Air," 18.

[131] Rosendahl, "Statement of Lcdr Rosendahl before the Federal Aviation Commission," 9.

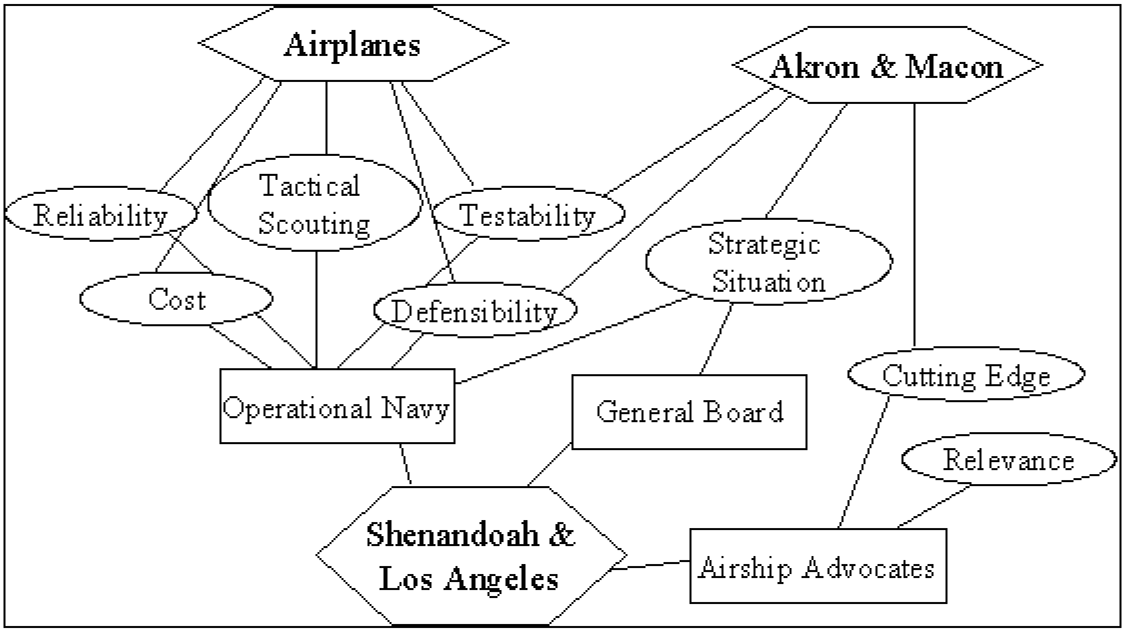

Table 13: Figure 2 Social Theory as it applies to the Operating navy, General Board, and Airship Advocates.

The effects of the advocates' focus on the General Board, Congress, airship techies, and the American public can be seen in the new generation of airships. Figure 11 shows how the new airships, *Akron* and *Macon*, responded to the problems of several major social groups. Alternative technologies are also shown in this graphic, which demonstrates how the airplane in particular was more effective at solving major problems of the navy at the time. The *Akron* and *Macon*, with their contingent of mini airplanes were better defended than previous airships. The existence of two identical airships can also be seen as an attempt to respond to the operating navy's need to test the machines. At several million each, however, the new airships were even less cost effective than the first two. Also, as they were an entirely new untested design, they could not be seen to provide high reliability. Finally, the *Akron* and *Macon* could not fulfill the navy's need for tactical scouting/targeting capability – there were too few of them and at their altitude communications with surface ships were too limited.

Beyond the social maps, Bijker's work and the work of the systems authors indicates potential scenarios given a set of social groups. In particular,

1. No social group is dominant
2. One social group is dominant
3. Two or more social groups striving for dominance

In the first case, if no social group is dominant, innovation will proceed along the lines of the technological frame of the producers. In the second case, a dominant social group will drive innovation to match its technological frame. In the third case, Bijker argues, criteria that are external to both technological frames will play an important role in shaping innovation of the new technology.[132]

Initially the airship case involved two or more social groups were striving for dominance of the airship. Congress and the General Board played strong roles in the initial decision to invest in the airship. The Operating navy, focused on tactical rather than strategic issues, played a minor role. As the General Board faded in importance and the operating navy increased its influence in Congress and with successive presidential administrations, the operating navy came to be the single dominant social group in regard to the rigid airship. The airship advocates were not prepared for this shift and did not recognize it when it occurred. The problems of the Operating navy, then, drove the advocates to more testable and defensible airships, the *Akron* and *Macon,* to respond better to fleet needs.

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[132] From "Simplifying the Complexity" in Bijker, *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*, 184.

By the time the *Akron* and *Macon* finally flew, however, the Operating navy's technological frame on the rigid airship had adapted. After eleven years of airship flights with little or no support to the fleet, the Operating navy had come to see the airships as a funding draw with little operational applicability. It was in this state that the airship first entered the fleet problems in earnest. There would be no third generation of airships to incorporate the navy's operational concerns.

Airships and the Systems Approach to Innovation

Unlike the sociologists of innovation, systems method authors attempt to bring more than just social elements into consideration of the innovation process. Thomas Hughes of MIT, central author in the field, uses thick description to integrate social, legislative, economic, and other factors into his discussion of the development of electrical networks.[133] Hughes proposes, based on this work, that technology development and innovation follows four phases. We will discuss each of Hughes' phases in terms of how it applies to the rigid airship case.

Phase1: Invention and development of the system is considered.

Hughes notes that inventors and entrepreneurs direct this phase. For the rigid airship, this first phase occurred between 1913 and 1921, before the airship advocates participated in the project. Because the airship already existed in Germany before the navy decided to make its investment, it was strategists, rather than inventors, who led this phase for the rigid airships. The General Board and Congress considered how best to pursue development of the new technology, and the adaptation to helium.

[133] Hughes, *Networks of Power: Electrification in Western Society, 1880-1930.*

Phase 2: Transfer of technology from one society or region to another.

At this point in the process, the systems builder begins to shape how the technology is brought into the organization. For the rigid airships Moffett is the clear systems manager. He has the background of experience in the navy and position of leadership given him through the Bureau of Aeronautics. The role of the systems manager, according to Hughes, is key to the technology and technological system. The successful systems manager manipulates and integrates technological, political, and economic matters into supporting the new technology. Moffett attempted to direct each of these areas as well, with varying success as we have seen. Hughes also notes that the systems manager can shape the development of a technological system through intentional and unintentional social “printing” by which his/her decisions socially shape the system.

Moffett’s printing shaped the rigid airships and the organization that supported them into a publicity mechanism. Even if this printing was unintentional, Moffett’s influence and association with the airship was so complete and enduring that even after his death the program could not reshape itself sufficiently to become a navy asset.

Phase 3: System growth.

Taking elements from the environment, and under the systems manager’s direction, the system grows. In the case of the rigid airship, this growth phase was truncated. Moffett, with the help of the General Board and congressional supporters, was able to draw funding from the environment (navy budget) for the airship. He was also able to garner support in the American public, and direct Fulton in regards to bringing new innovations (such as the portable mast) to bear. Moffett also expanded the system by funding the creation of the Sunnyvale base, increasing the visibility and range of action of the airships.

Phase 4: Momentum.

In this phase the successful technology has developed a strong supporting system, and sustains a given level of what Hughes refers to as mass, velocity, and direction. Mass includes physical artifacts, velocity refers to growth rate, and direction is a specific goal or set of goals for the technological system as a whole. This is the phase that the rigid airship never achieved. With an insufficient number of airships, both mass and velocity were unattainable. While the advocates had a perception of where the technology should develop to help the navy, it never developed to that degree.

One of Hughes' key concepts is the necessity to integrate factors from the larger environment into the technological system. John Law, an author of sociological innovation studies, echoes this view.[134] Law writes that all new technology is developed in a hostile environment. He introduces the term heterogeneous engineer, roughly analogous to Hughes' systems manager to describe the individual who draws formerly hostile elements into a network to sustain a given technology.[135]

The age of the airship came during a period of a particularly hostile environment, both at the national and naval levels. This sentiment was reinforced by budget limitations following the end of the War, and then by the onset of the Depression. The desire among national leaders to limit naval action and the realities of financial cuts made the national environment particularly hostile to the development of the rigid airship.

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134 Business and innovation historian of the Aluminum Company of America (Alcoa), Margaret B. W. Graham, argues that in the case of innovation in a research and development environment, both the role of science in society and the way in which research is funded and organized in a given organization must be taken into consideration. While the examination of the research and development environment of the rigid airship era is beyond the scope of this study, it would be a useful and informative approach for future work in this area. Graham, "R&D and Competition in England and the United States: The Case of the Aluminum Dirigible."

135 Law, "Technology and Heterogeneous Engineering: The Case of Portuguese Expansion."

The naval environment was also hostile to the development of the rigid airship. While there are some apparent biases that develop over the course of the history of the airship, initial hostility in the naval environment can be traced to funding mechanisms. The navy was not structured for investment in unproven technologies. Investment in aircraft of any kind demanded a new kind of approach, one that was even more necessary for the purchase of singular, expensive platforms.

In addition to national and low-level hostility, the rigid airship program also had to contend with an environment that was not designed to accurately assess and analyze new technologies. A modern engineer suggests that, "It is the essence of modern engineering not only to be able to check one's own work, but also to have one's work checked and to be able to check the work of others. In order for this to be done, the work must follow certain conventions, conform to certain standards, and be an understandable piece of technical communication."[136] There were no standards for evaluation of aerostation during the period of the airship, although the advocates were prepared to develop them. This lack of standardization in scientific evaluation was detrimental to airship development.

The fleet had difficultly evaluating the airship not only due to lack of interaction with the vessels themselves, but also due to lack of interaction with airshipmen. There were no qualified airship personnel on any of the command staffs in the fleet or available even just for the exercise.[137]

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[136] Henry Petroski, *To Engineer Is Human: The Role of Failure in Successful Design*, 1st Vintage Books ed. (New York: Vintage Books, 1992), 52.

[137] Rosendahl, "On Trial," 4.

Conclusion

Military models suggest that the navy was in a good position for successful innovation during the interwar period. The airship advocates, and the larger naval organization had the requisite factors success highlighted by military innovation theorists. Through the navy's General Board, the navy had a relatively defined vision of future warfare. This vision also existed at the national level through strategic warplans such as warplan orange. Through fleet problems and training opportunities, naval leaders developed and tested operational concepts to respond to their vision of future warfare. Doctrine, especially at the operational level, was concurrently developed. Finally, we have seen through the means of the Bureau of Aeronautics and the creation of the Scouting Fleet that the navy of this period was amenable to developing experimental organizations, for both administrative and operational functions.

Even the rigid airship program specifically seemed to have all the factors required for success, including high-level independent management and organizational participation. Using only the military innovation models, we could have expected the airship to be a success.

Social innovation models provide a different perspective on the airship case; Bijker's models highlight the challenges the advocates faced in selling the airship to various social groups. The advocates' focus on the American public, General Board, and Congress, to the detriment of the Operating navy foreshadows the failure of the rigid airship program within the navy.

Systems models, such as Hughes', focus on the progression of the airship within the navy environment and highlight where this progression broke down. The airship advocates fulfilled the expectations of the military innovation stories, but if we examine their actions using the sociological and historical/systems models they were not pursuing a path that would have led to successful innovation.

Chapter 7: Conclusion

The period of rigid airships in the navy can be broken into three phases: deciding on airships, the era of the airship advocates, and deciding against airships. Across these three periods the reasons for the failure of the airship can be discerned.

In the period in which the United States Navy decided to invest in rigid airships promises for their success were very high. The navy's strategic planners in the General Board looked to technologies that seemed successful in the First World War to help them solve the expected challenges of future conflict. The rigid airship seemed to be a platform with great potential and relatively low risk for the navy. The airship was in use during this period as both a military and commercial craft in Germany.

Viewing the German experience early in the War, the General Board was sufficiently confident in the new technology for both its military and commercial uses to seek development of an indigenous airship industry. Congressional leaders in the House Naval Affairs Committee supported this vision, appropriating funding for an initial two airships and a third when the first was lost during testing in England. Within the navy, some future planners were enthusiastic about the new technology, and began planning to provide personnel, training, and technological support for the airship. Many of these functions were combined in the Bureau of Aeronautics, a new organization under the charismatic Admiral Moffett with responsibility for both airships and airplanes.

When Moffett became the Chief of the Bureau of Aeronautics in 1921, he began the era of the airship advocates. A group of dedicated and enthusiastic officers would gather around him at the Bureau of Aeronautics. This group, between 1921 and 1928 took on the job of selling the rigid airship to the General Board, the American public, the Congress, and to some degree the Operating navy. Through public demonstrations, speeches, and Congressional testimony, the advocates ensured that the rigid airship held a firm place in the imagination of the American public that it has maintained to this day. The advocates also developed curricula, tactics, technical advances, and even a brand new class of airships to respond to the perceived needs of their audience.

The advocates' challenge lay in the growing opposition to a platform that although funded by naval budgets did not apparently support naval missions. Initial airship forays into annual naval exercises resulted in disappointment and eventually outright opposition from a growing number of important naval leaders. As the Bureau lost the American-built *Shenandoah* in a well-publicized accident, anti-airship sentiment increased. Journalists, public figures, and naval officers increased their public statements questioning the value of the platform even as the advocates pushed to speed development of the new airship class. Contract difficulties and construction challenges delayed the delivery of the new airships while naval impatience increased. When the new giant airships finally came online, however, they too had little time to participate in naval exercises. New platform tests and publicity took up the majority of in-flight hours. By the time Moffett was killed in the 1933 crash of the *Akron*, the navy had already turned solidly against the airship. When the final airship, the *Macon*, was complete, it flew only 20 months before crashing, and the navy would accept no further rigid airships in its force structure.

The history of events surrounding the decision not to further invest in the airship can be documented using archival material from the three periods of airship development. The perspectives and activities of the four advocates under study here are also documented.

The remainder of this chapter then will address the larger issue behind this history: What can the story of the navy's airships tell us about failed innovation?

In the first case, we should note that some authors consider the story of the rigid airship in the navy to be a case of false-failed, rather than failed innovation. Military thinker Gregory Wilmoth argues that false-failed innovations are those that appear initially to be failures, but in fact have a lasting relevance and importance. The initial impression of failure, as in the case of the airship, is based on development that does not result in an adopted technology in an expected timeline. In Wilmoth's words, false-failed technology is, "a technology that is examined and discarded but that gets a second chance under other conditions and succeeds."[138]

Using this metric, the rigid airship is a particularly good example of false-failure. Following the initial foray into the field during the 1920s and 1930s, the United States Navy has reconsidered the rigid airship concept in some depth multiple times, including most recently in the early twenty-first century.[139] Clearly the technology has an appeal that goes beyond the publicity efforts of the original airship advocates. The airship concept has resurfaced repeatedly in both military and commercial contexts.

While Wilmoth does not explore the factors that characterize a false-failed technology, some insights can be drawn from the rigid airship case. In particular, the rigid airship concept continues to respond to a central mission of its original client, the U.S. Navy. As the General Board laid out in the 1920s, the U.S. Navy has a basic and enduring

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[138] Wilmoth, "False-Failed Innovation," 51.

[139] The largest and best-funded modern military airship program belongs to the Defense Advanced Research Projects Agency (DARPA). The proposed airship, which has gone under the name Walrus, is designed to provide state of the art observation and detection as well as potentially heavy lift capability.

requirement for reliable strategic scouting and heavy lift. The former mission has been facilitated by the World War II development of radar and the post-war invention of space-based imagery and geo-location systems. But the second mission, distance transport of land forces and their weaponry, does not have a more modern or effective solution than traditional surface ship transport. Even as the army deployed to combat in the early twenty-first century, most assets, personnel, and supply arrived via sealift, a slow and potentially vulnerable means. As long as these two missions, strategic scouting and distance transport, remain a part of the navy's requirements, technologies that respond to them, such as the rigid airship, will resurface.

Additionally, the appeal of the rigid airship concept has increased with the development of better supporting technologies. The airship advocates were aware that ground handling was one of the major challenges of airship operations, and it is clear that limited helium supply made it impossible for the navy to maintain more than one rigid airship in an operational status at any given time. We can suggest that a false-failed innovation is one which had sufficient success in its original iteration to remain a positive part of collective memory, one that provides solutions or improvements to ongoing and likely future challenges, and one whose supporting technologies have continued to improve, making the original concept more viable.

What is failed innovation?

A key concern for this study, however, is why even a false-failed innovation fails in its first iteration. Using the basis of the rigid airship case, we can suggest three possible factors which may increase the likelihood of a first iteration failure. First, technological innovation fails when a new technology is faced with competing technologies that are too numerous or too successful early in their development. Second, a technological innovation fails when it is faced with competing concepts of application or social view that do not include the new technology. Finally, mismanagement or misunderstanding of the innovation timeline can drive failure. We will address each of these three factors in the following pages.

Failure due to Competing Technologies

The idea that a new technology has failed because it cannot improve upon the performance of a competing technology is perhaps one of the most commonly implied reasons for technological innovation failure. According to this reasoning, one technology simply outperforms the new innovation. This technology can either be a new invention itself, or be the tried and true approach to solving a given problem. A major competing technology for the airship was the airplane and its waterborne counterpart, the seaplane. While the airship flew before the first successful airplanes, the two technologies appeared to be reaching a level of reliable production during the same approximate time period. The two technologies also provided a degree of applicability to two military missions, scouting, and strike.

Despite the apparent threat from the development of the air/seaplane, from the beginning the airship advocates, and even the airship's opponents, saw the airship providing a capability that the airplane did not. In particular, the airship's ability to remain aloft for long periods, and at great distance from the shore and at sea support gave it unique capabilities for scouting, strike, and transport. In its second iteration versions, such as the *Akron* and *Macon*, scouting and potential strike capability was greatly improved by the addition of onboard airplanes.

While advocates and opponents initially identified differences between the roles and missions of the airship and air/seaplane, the airplane continued to develop its ability to operate farther from land throughout the period of the airship. Developments in wing design and fuel carriage greatly improved the air/seaplane's ability to operate for longer flight times and from various platforms at sea. As air/seaplanes began to acquire the capabilities initially identified for the airship, the air/seaplane became a much more serious competing technology.

The competition between airships and air/seaplanes within the navy was made more acute by the fact that the two systems were being developed within the same organization, and for the same customer, the operating navy. Budgets within the Bureau of Aeronautics became a zero-sum game between the airship and the air/seaplane. Airship historian Robinson asserts that, "while the airshipmen were fond of saying that the big rigids did not compete with airplanes, they complemented them, the competition was certainly intense when it came to dividing inadequate funds between airships and airplanes."[140] This competition may have enhanced the sense that the two platforms were competing for a similar mission. Additionally, the nature of the single large airship, expensive and few in number, made it a challenge for the airship to participate in many naval operations. For the price of one airship, the Bureau of Aeronautics could produce a large number of air/seaplanes which could be used at distinct geographic locations simultaneously. Seaplanes deployed with the fleet to Panama in 1922, eleven years before the *Akron* would

[140] Robinson and Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935*, 194.

participate in major navy exercises. These planes also participated in, "all the winter maneuvers of the fleet."[141]

A separate competing technology that is rarely noted in the case of the airship is the metalclad airship. These platforms, which were built in functional prototypes in the late 1920s, were smaller and less expensive than the large rigid airships. With their metal external shells, the metalclad also appeared to respond well to airship detractors critical of the platforms' vulnerability. The metalclad thus drew the attention of the President and Congress, turning investment focus away from the large rigids in the late 1920s, a period critical to the rigid airship's development. President Coolidge suggested, as he sent his budget to Congress in December 1926 that it might be the "better part of wisdom" to see how the metalclad fared before investing further into conventional airships.[142] By 1928 Fulton suggests that the President's preference for metalclads was starting to have an effect on Congressional funding thought.[143]

The final technology that provided dangerous competition for the large rigid airships was a predecessor: the non-rigid airship. The airship advocates made an important decision to distance themselves and their program from the non-rigid airships that the navy was operating. The non-rigids could be used for convoys, coastal patrol, antisubmarine work, and mapping and photography.[144] They were limited in their range, however, and were also more vulnerable to enemies on land and sea due to their limited altitude. The General Board had seen them as a potential training platform, but this view was not supported or

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141 McNamee, "Aviation and the Navy," 3.

142 Smith, *The Airships Akron and Macon*, 15.

143 Fulton, "High Spots in the History of Rigid Airships in the Navy."

developed by the advocates.[145] This decision may have been due to a concern that the public's view of the two platforms might become confused, leading to an impression that the rigid airship had limited capabilities. In fact, with its smaller size, the non-rigid would never have been able to take on the type of strategic scouting that was the rigid airship's main mission.[146] However, as the non-rigids could be easily and cheaply produced, the advocates might have more successfully employed them as a 'proof of concept' for the large rigid airships. The non-rigid airships could have been more readily available to demonstrate airship operations with the fleet and provided the operating navy an opportunity to operate with airships. As it was, the navy maintained a limited non-rigid balloon unit which had little or no association with the large rigids.

Competing technologies presented several challenges to the large rigid airships during their development. Perhaps most importantly, the airplane and seaplane encroached on the airship's defined mission of strategic scouting, and appeared to offer what seemed to be an ever-increasing capability to operate at sea. The air/seaplanes were also in direct competition with the rigid airships for funding within the Bureau of Aeronautics. Metalclad and non-rigid airships also presented competition; in large part due to their relative affordability.

Failure due to Competing Concepts

The airship also had to contend with competing concepts during its development. The main concept affecting the airship's development was how the navy

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[144] C E Rosendahl, "Lighter-Than-Air Machines," *Proceedings of the American Philosophical Society* ixvii, no. 4 (1928): 323.

[145] General Board, "Report of Board to Consider and Recommend Upon Present Aeronautic Policy," 2.

should adopt and integrate airborne capabilities. Peter Paret summarizes this challenge in his *Innovation and Reform in Warfare*. He writes, “How can men attune their minds as clearly as possible to the constantly changing conditions and demands of war? How do military institutions adjust to new realities, what forces carry innovation forward, and what obstacles stand in its way?” Paret notes that, “these questions outline only one aspect of the problem.” The most important problem of innovation, he writes is, “not the development of new weapons or methods, nor even their general adoption, but their intellectual mastery.”[147] The navy’s ability to ‘intellectually master’ the airship was based on a combination of American social views of the craft, and how well the airship fit into existing naval concepts.

In terms of American society, the airship stood as a singular vision of power and size. But it was not well-suited for the public’s desire to own and fly their own craft. Roger D. Launius points out in his introduction to his edited volume, *Innovation and the Development of Flight,* that, “Rivalries between cities, between states, and on the national level were important attributes of the development of western aviation.”[148] Moffett knew this as well, and encouraged as much as possible participation in competitive air events for the airplanes under his control at the Bureau of Aeronautics, but this type of competition was not possible for the limited numbers of airships available.

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146 Non-rigid airships were useful in situations where the scouting environment was near to shore facilities, such as in the North Sea during World War I. During all of World War I, non-rigid airships patrolled over 80,000 hours covering 2.5 million miles of territory. Fulton, "Lighter-Than-Air Aircraft."

147 Peter Paret, *Innovation and Reform in Warfare*, The Harmon Memorial Lectures in Military History; No. 8 ([n.p.]: United States Air Force Academy, 1966), 2.

148 Roger D. Launius, *Innovation and the Development of Flight*, 1st ed. (College Station: Texas A&M University Press, 1999), 10.

As an asset not available to the pubic, the rigid airships missed much potential experimentation and enthusiasm from the public. Eugene Vidal, director of the Bureau of Air Commerce, even proposed a plan whereby aircraft would be as generally available in America as cars. He held a competition for 'Everyman's Airplane' in the mid-1930s.[149] Vidal saw his market in the depression-era 'forgotten man' who was, "a private flyer, and his brothers are legion…they build model planes by the millions and trudge out to local airports each week-end to worship their idols from the ground and long for the day when they will have saved enough wherewith to buy a hop."[150]

The airship also held a somewhat negative history in the eyes of the American public. In his *To Engineer is Human*, Henry Petroski develops the concept of symbolic nature in his case studies of engineering design. Petroski compares the symbolic nature of the architectural monument, such as a pyramid, to that of a bridge, noting that monuments "were erected as tributes to earthly and heavenly rulers, but bridges are principally functional structures." [151] The 'symbolic nature' of the airship may also have reminded the American public of unmatched German raids during the First World War. The airplane, which foretold American military success in that combat, had a more favorable public history.

As the rigid airship program progressed, and suffered well-publicized crashes, those images came to symbolize the airship for the American public. Perhaps most importantly,

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[149] See Tom D. Crouch, *A Dream of Wings: Americans and the Airplane, 1875-1905* (Washington: Smithsonian Institution Press, 1989).

[150] Crouch, *A Dream of Wings: Americans and the Airplane, 1875-1905*, 169.

[151]Petroski, *To Engineer Is Human: The Role of Failure in Successful Design*, 57.

the airship was seen as particularly associated with Admiral Moffett. When he lost his life in a crash, the public may have perceived this to be the end of the airship program.

The airship also did not fit neatly into navy warfare concepts of the time. In theory the large powerful airship should have matched well with concepts of maritime power of the period. It was aesthetically appealing to the traditional naval officer. Naval historian William McBride points out that, the "big rigid airship, when compared with the flimsy and dangerous airplanes of the day appealed to senior officers of Moffett's generation…[who] could identify with an aerial craft longer than a dreadnought, ponderous and stately like the ships they had grown up with at sea."[152] The airship might have fulfilled what naval historian Edward Beach calls, "the cynosure of naval capability; the greatest ship that could be built…"[153] This appeal to the older generation of the navy may have made the airship less popular with naval leaders emerging out of World War I. The airship, as a singular large platform did not appear to support the type of naval warfare presaged by Mahan and taught at the Naval War College, which was focused more on firepower than on observation or strategic scouting.

The airship advocates and their new technology were subject to the navy's concept of warfare, which was focused more on strike than strategic scouting, the airship's main mission. The situation was made more challenging by the fact that the advocates were not able to direct the ways in which the airships would be used when they did exercise with the fleet. The advocates repeatedly declared that the rigid airship was designed for

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152 McBride, "Technological Change and the U.S. Navy," 186. Robinson and Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935*, 193-194.

153 Edward Latimer Beach, *The United States Navy: A 200-Year History*, The American Heritage Library (Boston: Houghton Mifflin, 1987), 423.

long-range scouting, but did not have the opportunity to test it in that type of environment, in part because the navy didn't see it as a platform for that capability, and had a poor definition of its requirements for long-range scouting. Consequently, when airships were able to participate in exercises, they were employed in missions for which they were not designed, making them look even less useful to the navy.

Rosendahl wrote to Fulton in 1925, that, "Airships have in many cases been victims of 'human equation' errors in one form or another, in design, construction, and operation."[154] The error to which Rosendahl referred was not only concrete. He was also suggesting that the advocates and the airship had become the victims of competing concepts.

Failure through Misunderstanding or Mismanaging the Timeline

The final factor affecting failed innovation is the misunderstanding or mismanagement of time allowed for innovation. Successful innovation has to manage the window of available time for alterations to the new technology and its supporting technologies. Within this window, relevant social groups need to see that the technology provides a resolution for their problems, and is able to adapt to meet their needs. While we can refer to a timeline or window of time, one of the main challenges for innovators is that there is no specific definition of how much time is available to them to ensure the viability of their technologies.

After the *Shenandoah* was destroyed there was a sense among some that enough time had been allotted for the navy to determine the value of this type of vessel. Engineering magazine editors wrote, "two years' experience with the *Shenandoah* should have been sufficient to determine the value of such craft as an adjunct to the fleet, whilst the twelve months' very active commission of the *Los Angeles* should have indicated whether the airship was likely to prove a successful commercial venture. As yet, the responsible authorities have ventured no public pronouncement on naval or commercial airships, although it has been recently announced that the closing of Lakehurst naval airship station is contemplated in next year's estimates."[155] While the station was not closed that year, the advocates did receive constantly mixed messages indicating how long the navy would allow development to continue. During an unspecified development timeline, the successful system manager will manage the availability of the new technology, ensure the provision of required supporting technologies, and market the product to the right constituent.

Managing availability of the airships was a major failure for the airship advocates. During the period of the rigid airships, there was rarely more than a single airship operational, and that most often was the *USS Los Angeles*, the only airship prevented from military activity due to its war reparation status. The limited availability of airships meant that there was limited time for operating with the fleet, and that transit time between locations was particularly costly. For many in the navy, the airship remained a ghost ship that was rarely sighted.

The airship advocates spent a good deal of their effort working to manage the provision of supporting technologies, and this situation did improve over the life of the rigid airship program. The two technologies that were essential to the platform were helium and

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[154] Rosendahl, 7.

ground-handling equipment. Helium, limited by the natural supply, would limit airship operations throughout the period of the rigids. Even when the program did have two airships, the national helium supply was insufficient to keep both aloft. Ground-handling technologies had a similar limiting effect on the airship program. The airships were most likely to be damaged in the dangerous ground-handling phase of their operations. Also, the fact that the airships required extensive ground-handling equipment made the platforms less flexible in terms of relocating. The airship advocates, in particular Fulton, worked on this problem for the duration of their tenure. Portable masts and railroad-driven masts to maneuver the airships into their sheds were developed, but were still too complicated, expensive, and limited in number for the program as a whole.

Finally, the advocates did not realize that as time passed their main constituent shifted from the General Board and Congress to the operating navy. As acquisition, rather than operation, organizations, it is likely that the role of the General Board and Congress would decrease regardless of the timeline under question, but the elongated development timeline, with its multiple delays meant that the advocates were even less prepared to deal with their operating navy audience. They suffered, in the words of airship historian William Smith, from, “The pernicious effects of too much barnstorming”[156]

In the case of the rigid airship, significant delays caused the advocates to achieve insufficient success in the time available for the rigid airship’s development. Delays in construction, and in replacing the airships that were destroyed in accidents caused the airship’s main constituent social group, the operating navy, to doubt the success of the

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[155] Charles E. Rosendahl, "The Wreck of the Shenandoah," *Engineering Magazine* (1925): 360.

venture. The airship advocates' delays in acquisition also allowed other technologies to seem like they provided a cheaper option, such as the metalclad. Each year lost in delay allowed for the possibility of shifts in allegiances and relevant actors. For the airship, lost time meant the decreasing importance of the General Board, their initial supporter.

The airship case indicates several factors that can contribute to innovation failure at an organizational level. Threats from competing technologies, competing concepts, and the mismanagement or misunderstanding of the development timeline demonstrate how challenging successful innovation can be, even for the most ardent advocate.

[156] Smith, *The Airships Akron and Macon*, 5.

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Appendix: Literature Review

Secondary Sources

Airships

There are two major dissertations that pertain to the navy's rigid airship program, Richard K. Smith's *The Airships Akron and Macon*, and Martin L. Levitt's *The United States Navy and Lighter-than-Air Aviation*.

Smith's work is narrower, and focuses on only two of the four rigid airships flown for the U.S. Navy. His main interest, writing in 1965, was to further the availability of solid academic research on airships and the *Macon* and *Akron* in particular. Smith focused on organizational and official archives, especially from the Bureau of Aeronautics and the navy General Board. He did not reference personal papers or archives in his bibliography. Smith's dissertation provides a strong grounding in the facts surrounding the navy's rigid airship program.

Levitt's work traces development of rigid airships in the United States Navy from the advent of airpower through the decommissioning of the lighter-than-air craft in 1962. His work is broader in scope than that of Smith, but also drew on limited personal papers. He references in particular the biographical files at MIT and the Rosendahl collection. The majority of his primary sources are drawn from organizational and official files.

Smith notes that, "Most secondary sources on the subject [of the U.S. Navy and airships] have rehashed the same threadbare information, misinformation, myths, and hearsay of the past thirty years. The majority have been more concerned with exploiting the entertainment value of the airships' inherent sensationalism than with trying to understand the subject."[1] Since Smith wrote these words there have been some more serious contributions to the secondary source literature on rigid airships, but the field remains only lightly developed. Two works of note are Douglas Hill Robinson's *Giants in the Sky* and William Althoff's *Sky Ships*. The majority of works, however, do tend to focus either on sensational aspects, or technical assessments that are beyond the scope of this dissertation.

U.S. Navy in Interwar Period

There are several general works on the navy during the interwar period that provide assistance in conveying the larger organizational mores of the period as well as strategic challenges and relations with other services. In particular, Trimble's new biography of Admiral Moffett, Vincent Davis' *The Admirals' Lobby*, and Hone and Mandeles' *American and British Aircraft Carrier Development 1919-1941* are useful secondary sources, as well as general histories such as Love's *History of the U.S. Navy* and Roscoe's *On the Seas and in the Skies*. Additionally, some works directed at social, political, and institutional studies of this period, such as *The Great War and the Search for a Modern Order* and help to provide a larger view of how the airship was seen by Congress and the American public.

Innovation and Military Innovation

In addition to secondary works that address airship in general and the state of the U.S. Navy in the interwar period, this dissertation will draw on some secondary studies of innovation. As discussed above, the most important innovation studies for this dissertation will be those that address military innovation in particular. There are many studies of success in military innovation, and few of failure. Murray and Millet, in their *Military*

[1] Smith, *The Airships Akron and Macon*, 219.

Innovation in the Interwar Period, as with many others including Charles M. Melhorn and Thomas Hone, have examined the growth of naval aviation in the interwar period. All have concentrated, however, on the impressive development of carrier aviation, rather than rigid airships. From the role of wargaming at Newport to the larger-than-life personalities, the success of carrier aviation is appealing and interesting. Murray and Millet have used their study of the interwar period as a basis to describe a concept of military innovation. They suggest that some organizations manage to innovate because "some individuals develop better intuitions about future warfare than others."[2]

Stephen P. Rosen, in his *Winning the Next War*, suggests that innovation is inherently tied to organizational structure: "Peacetime innovation has been possible when senior military officers with traditional credentials, reacting not to intelligence about the enemy but to a structural change in the security environment, have acted to create a new promotion pathway for junior officers practicing a new way of war."[3] As the dissertation progresses, research will likely indicate which of these theories is the most interesting and relevant to the discussion of rigid airship development.

Other works addressing military innovation in different time periods, such as *Innovation and the Arms Race* by Matthew Evangelista, or works that address innovation in other militaries such as Thomas Mahnken's *Uncovering Ways of War*, may indicate interesting perspectives on innovation that are also relevant.

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[2] Murray and Millett, *Military Innovation in the Interwar Period*, 381.

[3] Rosen, *Winning the Next War: Innovation and the Modern Military*, 127.

Research Materials

This dissertation will rely primarily on the personal archives of the five naval officers discussed above. Each of the five officers' archives has an extensive finding aid. Secondarily, smaller personal archives and organizational and official collections will be incorporated. Due to the emphasis placed on them, each individual's archive will be discussed here in some detail.

Personal Archives

Admiral William A. Moffett, Nimitz Library, U.S. Naval Academy, Annapolis, MD

In his biography of Moffett, William F. Trimble suggests that, "Throughout his tour as bureau chief Moffett touted the airship as part of the solution to the daunting strategic problem faced by the navy in the vast reaches of the Pacific."[4] Other authors see Moffett's support of the airship program as "ill-fated enthusiasm."[5] Either way, Moffett represented the highest level of support for rigid airships within the navy organizational structure.

Admiral Moffett's papers are distributed in several locations, however, the most relevant personal files are to be found at the U.S. Naval Academy. The collection there includes six feet of personal papers. These will be supplemented by Moffett's many published works and presentations at hearings found in organizational and official archives described below.

Captain Garland Fulton, National Air and Space Museum Archives, Washington, DC[6]

Captain Fulton's most important position in relation to rigid airship development was as head of the lighter-than-air section at Bureau of Aeronautics where he was first

[4] Trimble, *Admiral William A. Moffett, Architect of Naval Aviation.*

[5] Murray and Millett, *Military Innovation in the Interwar Period*, 394.

assigned in 1921. Fulton facilitated the development and transfer of the *USS Los Angeles* from its development to delivery and first trans-Atlantic voyage. Richard Smith claims Fulton, "exerted a greater influence on the direction of the navy's lighter-than-air aeronautics than any other individual not in a policy-making position."[7] Fulton regularly represented Admiral Moffett at General Board and Congressional hearings.

The National Air and Space Museum archive collection includes 45 boxes of Fulton's materials, including documents dating from his time at MIT where he obtained a Master's degree in 1916, as well as documentation from his tenure as the head of the lighter-than-air branch of the Bureau of Aeronautics.

Fulton's archive is divided into nine series, addressing broad subjects generally dealing with naval aeronautics. His work on lighter-than-air issues is grouped into a single series. The most relevant documents from this collection will likely be his correspondence and personal writings. Fulton maintained correspondence with Vice Admiral Rosendahl, Admiral William Moffett, and Jerome Hunsaker, as well as with airship designers such as Karl Arnstein and Hugo Eckener. The correspondence, which are arranged by year,[8] run from 1912 through 1974.

Beyond correspondence, Fulton wrote extensively on the development of lighter-than-air, and was working on a history of U.S. naval aviation when he became ill and died. The papers included in his series on lighter-than-air and general aeronautics are in many cases background writings for his intended book. This type of collection provides a general

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[6] Accession Number XXXX-0101.

[7] Smith, "Navy's Flying Aircraft Carriers", 7.

[8] Undated correspondence, especially between Fulton and Rosendahl, are collected in a separate folder.

background from that time period of a serious scholar. In his collection, Fulton paid particular attention to documents relating to airship policy within the United States in general and the navy in particular. Documents such as the three folders of transcripts from Congressional Hearings on navy LTA Policy, and documents that demonstrate, “efforts by the leaders of the navy to influence legislation public policy and legislation favorably for the navy’s airship program.”[9]

Vice Admiral Charles E. Rosendahl, University of Texas at Dallas, TX

A graduate of the naval academy, Vice Admiral Rosendahl came to airships from a background in battleships. He was an operator who was navigator of the *Shenandoah* and commanding officer of the *USS Los Angeles* and later *USS Akron*. Rosendahl was one of the strongest advocates for naval rigid airship development.

Rosendahl’s archive is one of the largest lighter-than-air collections in the world, and includes 343 boxes of material. It contains rigid airship publications, manuals, and training materials as well as his personal correspondence and notes. As the single largest compendium of lighter-than-air materials it also contains a significant amount of material that is less relevant to this dissertation, such as a copy of the *USS Macon* Christmas Card. The finding aid for this collection is fortunately detailed, and highlights areas of particular interest within the vast archive.

While the Rosendahl collection contains an enormous amount of information, the first 38 boxes of the collection are devoted to photographs, and thus are of little interest to this dissertation. Similarly, the last 143 boxes deal with dates from the 1950s onward and

[9] Allan Janus, *Garland Fulton Collection* (Washington, DC: National Air and Space Museum Archives, 2003), 6, Finding Aid.

thus are not relevant to this dissertation. Among the remaining files, boxes 39-58 are the most interesting. They deal with Vice Admiral Rosendahl's manuscripts, including typescripts for *Up Ship!*,[10] articles, transcripts, and official testimonies of Admiral Rosendahl.

Among Rosendahl's correspondence are notes and telegrams exchanged with Admiral Moffett when he was Chief of the Bureau of Aeronautics. Official memoranda are logged separately by year and, combined with personal letters, may provide insight into the relationship between official and unofficial positions on the airship argument.

Training information is also extensive within the Rosendahl archive, including training aids for instruction from the 1920s through the mid 1940s. The progressive improvement of rigid airship training programs is evident in the material, which indicates the changing requirements for the men and officers who received the designation "Naval Aviator Airship."

Captain George Mills, National Air and Space Museum Archives, Washington, DC[11]

Captain Mills began training as a lighter-than-air naval aviator in 1931, he later served on the *USS Macon*, surviving its crash, and became the commanding officer of the Naval Air Station at Lakehurst, New Jersey. Captain Mills is described by National Air and Space Museum archivists as a member of the navy's inner circle of advocates of lighter-than-air flight. He continued after the period of the large rigid airships to be a

[10] Robinson and Keller, *Up Ship! A History of the U.S. Navy's Rigid Airships 1919-1935.*

leader in the field of lighter-than-air as non-rigid airships came to dominate the navy's program. While a significant portion of the Captain Mills archive deals with the post-1935 period, he took pains to collect information addressing the early period of rigid airship development as well. The documents pre-dating 1935 are of the most relevance to this dissertation.

The Mills papers at the National Air and Space Museum archives include correspondence, papers, and publications. They comprise approximately fourteen feet of material, span Captain Mills' career in the navy, and are divided into nine series. Of particular interest for this dissertation is the series comprising Mills' correspondence. A mainstay of this series is the correspondence between Captain Mills and Vice Admiral Rosendahl and Garland Fulton. Some of his early lectures, speeches, and papers, that make up another full series, will also provide insight into Captain Mills' role in the development of rigid airships in the navy.

Beyond the clear relevance of correspondence and writings of airship advocates, the Mills archive also includes a series entitled, "General Lighter-Than-Air Papers" that includes several studies of rigid airship effectiveness in World War I. This series, includes assessments by the Germans, British, and American naval officers, as well as a 1936 study by Garland Fulton on the vulnerability of airships in the First World War. Together, these may indicate some of the strategic-level interest and thinking behind rigid airship development in the navy. As with the other personal archives, the Mills archive also

[11] Accession Number 1994-0022.

includes some documents from official and organizational sources, such as reporting from the Congressional Joint Committee to Investigate Dirigible Disasters.

Other Personal Archives

Hammond J. Dugan, Maryland Historical Society Archives, Baltimore, MD

The Dugan archive has been written up in the Maryland Historical Magazine but not used in academic works on airships. Thom Hook, author of *Sky Ship*, makes special note of the archive and the value he found in it, but his work cannot be considered academic in nature, and falls more into the category of sensational history.

Hammond Dugan was a naval officer in the lighter-than-air program between 1923 and 1933. His archive includes papers from his time at MIT as well as naval handbooks, logs, and manuals. The items in the collection date from 1929 to 1951. Dugan assembled scrapbooks and notebooks relating to the flights of the *USS Akron* and, "the Aftermath of the *Akron*." Dugan wrote his master's thesis at MIT on the *Akron* and materials from this study will be useful for establishing facts as well as a perspective from a more junior officer who served aboard the airship. Due to his short tenure with the airship program, and his relatively limited involvement at the policymaking level, Dugan's experience is limited to providing background insights to this study.

In addition to clippings of contemporary articles about airships from journals such as the *United States Naval Institute's Proceedings,* the Dugan archive also includes personal letters and reports. The most relevant of these letters of course will be any that reflect correspondence with other airship advocates.[12] The Dugan archive also comprises

[12] The Dugan finding aid is the most limited of those examined here and does not provide information on who Dugan corresponded with. I plan my first trip to this archive for early November, 2005 to develop a better sense of the materials it contains.

more training and education-related materials, including a navy manual on lighter-than-aircraft and material relating to lighter-than-air classes that Dugan took at MIT.

Organizational/Official Archives

Three main sets of organizational or official archives are relevant to this dissertation, records of Congressional Hearings, records of the navy General Board, and records from the Bureau of Aeronautics. I plan to use these archives both to support the personal papers of the airship advocates discussed above and in order to convey a sense of how the larger navy establishment reacted to the airship and its advocates. In the case of Admiral Moffett especially, both hearings and records from the Bureau of Aeronautics will be particularly relevant. These archives are all located in the Washington DC area, and are divided between the Library of Congress and the National Archives and Records Administration.

Records of Congressional Hearings

Records of Congressional hearings are available at both the Library of Congress and the National Archives and Record Administration. For this dissertation, several subcommittees are of interest. Most notable, the House Committee on Naval Affairs Subcommittee on Aeronautics will provide information regarding the national view of rigid airships and detailed studies of particular events such as the 1933 "Investigation into the Loss of the *USS Akron*." Both the Senate and the House of Representatives have records from their Committees on Naval Affairs that will be of some interest both in establishing the general tenor of naval issues of the day and also providing specific testimonies by airship advocates. Further, a Joint Committee dealing with the Investigation of Dirigible Disasters is relevant.

Records of the Navy General Board

The General Board of the navy made important decisions concerning ship design, investment, and naval strategy and policy from the early 1900s through 1960. For this dissertation, hearings on naval policy held by the General Board are perhaps the most relevant portion of the General Board records. They consist of fifteen reels of microfilm and are held at several facilities in the Washington DC area, including the Library of Congress and the United States Naval Academy's Nimitz Library. Each includes an index that is searchable by subject and will provide detailed information of how Admiral Moffett in particular, as well as other airship advocates represented the rigid airship to the navy's decisionmakers.

Records from the Bureau of Aeronautics

The Bureau of Aeronautics, led for several years by Admiral Moffett, was a key component in U.S. Navy decisions regarding airship development. The records of the navy's Bureau of Aeronautics are held at the Downtown facility of the National Archives and Records Administration. Of particular relevance will be the correspondence files dating from 1925 to 1947. These include unclassified and formerly classified correspondence from this period as well as an index and card register. The records of the General Board are held in Record Group 80 and General Board correspondence is in the ZR files of Record Group 72.3.1.