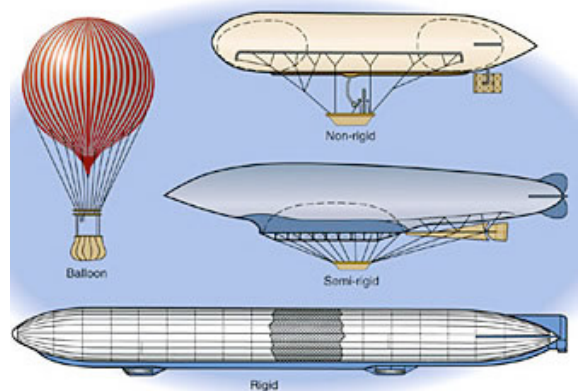


**To what extent does modern technology address the problems of past
airships?**

Ansel Sterling Barnes

Today, we have numerous technologies we take for granted: electricity, easy internet access, wireless communications, vast networks of highways crossing the continents, and flights crisscrossing the globe. Flight, though, is special because it captures man's imagination. Humankind has dreamed of flight since Paleolithic times, and has achieved it with heavier-than-air craft such as airplanes and helicopters. Both of these are very useful and have many applications, but for certain jobs, these aircraft are not the ideal option because they are loud and waste energy. Luckily, there is an alternative to energy hogs like airplanes or helicopters, a lighter-than-air craft that predates both: airships! Airships do not generate their own lift through sheer power like heavier-than-air craft. They are airborne submarines of a sort that use a different lift source: gas. They don't need to use the force of moving air to lift them from the ground, so they require very little energy to lift off or to fly. Unfortunately, there were problems with past airships; problems that were the reason for the decline of airships after World War II: cost, pilot skill, vulnerability to weather, complex systems control, materials, size, power source, and lifting gas. This begs the question: To what extent does modern technology address the problems of past airships? With today's technology, said problems can be managed.

Most people know lighter-than-air craft by one name or another: hot air balloons, blimps, dirigibles, zeppelins, etc. This paper excludes hot air balloons, since as Samuel Johnson stated in 1784, “[balloons] can serve no use till we can guide them,” and focuses on airships (Crouch 68). Paul Haenlein was the first to fit an airship with an



internal combustion engine in 1872 (Crouch 72). There are many kinds of airships (Beaubois 10). **Blimps** are **non-rigid airships** with a suspended control cabin, where the lifting gas pressurizes the skin of a single envelope. They are also known as **pressure airships**. Pressure airship design does not have a solid frame on which to mount engines. The control cabin is the only place to attach them. Blimp design must remain fairly small, since the pressure inside the envelope is harder to safely maintain as the airship gets larger. The most famous blimp is the *Goodyear Blimp*. Blimps are the most common airship today. The name **dirigible** includes both semi-rigid and rigid airships. **Semi-rigid airships** have an internal structure that runs along the underside of the lifting envelope. This allows engine attachment to structures besides the control cabin, thus reducing engine noise. It allows for larger envelopes, improves gas capacity, and provides more lift, making the airship easier to control. An example of a famous semi-rigid was the *Norge*. The only semi-rigid airships that exist today are the *Zeppelin NT* series. **Rigid airships** are the largest type of dirigible and have a complete internal skeleton as the structure for the lifting envelope (Archbold 146-51).



Catwalks and ladders inside the metal structure provide the crew with full access to the many gas cells. The axial catwalk stretches from the very nose of the airship, where the mooring cone is, to the tail of the airship, where the fins are.

Ladders connect to the axial catwalks and extend up to the “roof” of the airship and down

to the keel catwalk, which runs along the inside belly of the ship and extends to the control cabin and engine cars. Rigid, such as famous *Hindenburg*, are the largest of the airships and have the greatest lifting capacity. The name ***Zeppelin*** refers only to airships manufactured by the Luftschiffbau Zeppelin GmbH, a company named after Count Ferdinand von Zeppelin . He founded it in 1899 and it still exists today. He also began the “Golden Age of Airships” with the construction of the LZ-1 in July, 1900. The Golden Age of Airships lasted a very short time from 1900 until certainly 1937, and possibly until 1947. It wasn’t until the 1980’s that Luftschiffbau Zeppelin began to reinvest and design airships again. On July 2, 2000, the company christened the new prototype Zeppelin NT: the *D-LZFN Friedrichshafen*. It is currently flying routes over Germany and middle Europe.



Airships have many abilities: they have an almost unlimited range, they can remain aloft for weeks or even months, they can carry enormous weight while expending very little energy, and they require very little infrastructure such as roads to transport goods since the air is already there! They can fly in the fog and at night, which was very important during the World Wars. They can be very stealthy in such conditions during reconnaissance, since they do not require engine power to remain aloft, making them

silent and invisible in the dark. In fact, Britain considered German airships enough of a threat during World War I that they established a “Royal Flying Corps” of plane pilots to shoot down or bomb German Zeppelin airships (Grahame-White and Harper 36).

Please refer to the image of the Hindenburg airship design in the Appendix before reading further (Archbold 146-47).

Unfortunately, airships are very complex and therefore have many variables to control. To begin with, lighter-than-air craft have to be much, much larger than their heavier-than-air craft counterparts because of the required envelope for lifting gas. That means expense is one of their biggest enemies. The majority of airships designed never got out of design, much less on the field. Even in 1927, the US Navy spent roughly *\$4.5 million* to build the USS Akron, which was the fastest rigid airship ever built, and was one of an entire fleet of Navy dirigibles . Many reasons the cost was high had to do with materials cost and extremely high labor costs. Airships require light but sturdy components. For instance, in rigid airships, the aluminum latticework was only 1/5 of one millimeter thick! The envelope or the gas cells had to be gas-impermeable and sturdy enough to resist bursting under pressure and to withstand the elements. According to Capt. L. Chollet in L’Aeronatique, “...it is important to obtain the most perfect tightness possible for airships, which must remain inflated for many months and for which the least diminution of the lifting force affects the carrying capacity.” (Chollet 1) This required either a rubberized fabric or “goldbeater’s skin,” a material created from treated ox or calf intestines. Joining strips of this material together required a special process to fuse it together and then required human examination and further treatment. This could easily require another entire paper related just to the advances in the materials used for the

airship envelope alone: paper, cloth, silk, skin, etc. Portals in the control cabin and, if applicable, passenger area, had to be light, sturdy, and transparent, so were constructed of either glass or Plexiglas. The control cabin itself was often a thin metal, such as aluminum or Duralumin. Duralumin, an aluminum-copper-manganese alloy, was created by a German metallurgist, Alfred Wilm in 1909, and was perfect for the job. This could not be used for the engines themselves. The first engine Giffard used required 500 pounds of coke to power a 350 pound steam engine that only generated 3 horsepower. Compare that to the Hindenburg's five diesel engines, which ran on diesel and generated up to 1300 HP for takeoff and ran at 850 HP during flight!

Probably the second biggest issue for airships was the critical nature of crew and captain skill. The best airship captain of the day was indisputably Dr. Hugo Eckener. Over and over again, he overcame dangerous situations encountered in flight through sheer talent. There were far more examples of when crew error destroyed airships: the Hindenburg is the most famous, but there were countless others. Inexperience with the rudder, overstressing the airship structure through quick maneuvers, poor decision-making in bad weather, lack of foresight about coming weather, and other issues all made safe flights more rare than they should have been. Such incidents decreased their popularity.

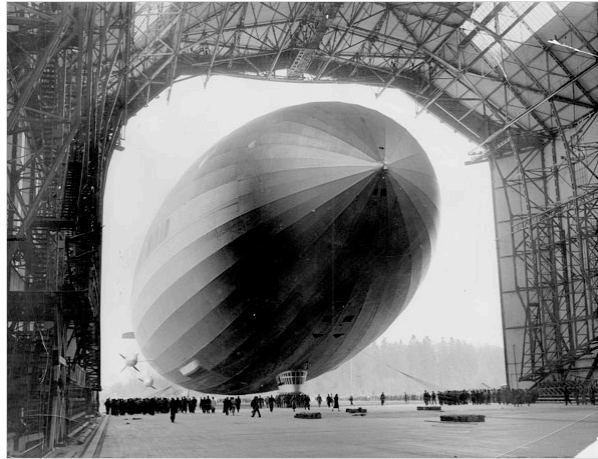
Pilot skill was most challenged by weather. Weather endangers all forms of flight, but especially airships (Botting 168). Particular dangers include condensation of moisture on the envelope, which can weigh it down and waste ballast, turbulence, which can blow the airship off course or out of control, fog that obscured terrain and the stars, etc. That made running the elevator and rudder wheels one of the most important jobs on the airship,

since weather and turbulence are the airship's biggest threats. Eckener was so skilled at flying his airships, that he successfully conducted an Arctic scientific expedition in an airship (Ellsworth 61), as well as circumnavigating the globe and many transatlantic passenger flights (Botting 183).

Another challenge is the complexity of systems control for Golden Age airships. Every system in the airship, the ballonets, the rudders, the elevators, ballast, lifting gas, everything, was controlled manually by crewmen. Each system involved careful balancing and quick decision-making. Any mistake could critically endanger the airship. Lifting gas is certainly the most important component of any airship, then or now, since this is what provides the airship with all its vast capabilities, providing lift. There are only two types of lifting gas to date: hydrogen and helium. Common hydrogen gas has been used since the dawn of airship age and can be found worldwide. It is comparatively cheap to produce, but is, unfortunately, also quite flammable and explosive. Most rigid and semi-rigid airships of the day used hydrogen because it was lighter than air and the required huge quantities of it. Helium was discovered as an element in 1868, and the first helium reserves were restricted to the United States after discovery in 1903, so the U.S. had a monopoly on it. Even though helium provides only 92.6 the lift of hydrogen and is extremely expensive, it was still considered better than hydrogen because it is not flammable; it is a completely inert noble gas. After the Hindenburg disaster, helium became much more appealing.

In addition, the required size of airships is also a challenge. Lighter-than-air craft require lots of gas to lift the ship. That means huge sheds, much larger than aircraft hangars must be built to build and store them. This is a major drawback because it's

expensive. The Hindenburg required its own special factory shed, since it was too fat for the existing Zeppelin factory. The shed's inner dimensions were 787 feet long and 115 feet tall (Grossman).



Today's airships have solutions to many of these problems. Technology advances such as computers, plastic materials, knowledge of the periodic table, and mastery of electricity all offer assistance in designing, building, flying, and storing airships. Computer and programming alone can solve well over half of the problems listed. For instance, simulators can now provide airship pilots a chance to practice their craft without endangering real airships or crew. Such training can reduce risk to airships and to their reputation. Additionally, radar and weather prediction systems can provide forecasts to plan flights and also to adjust them in real time. Satellites now provide airships with a very accurate navigation system, instead of relying on the stars, faulty maps, and the risks of uncharted territory. Systems control of all airship components can be performed digitally and often, automatically, reducing the crew size. New advances in plastics and alloys and manufacturing methods allow current manufacturers to more closely match the needs of airship materials and components, providing higher quality materials at a lower price. Today, some groups like DARPA (in the military) have proposed roofing natural

canyons for at least constructing the airships to handle size limitations. As for engines and sources of power, electric motors are cheaper, lighter, and more efficient than engines of past airships. Modern technology allows designers to directly harness nature's energy sources, such as solar power. All of these technologies help reduce the cost of building and maintain airships and make economically feasible. Modern technology addresses many of the problems of past airships, involving basic design and desired usage. With such technology in its arsenal, a modern airship has innumerable uses: as heavy cargo lifters to remote areas where roads are impossible (Prentice 1), as high altitude airships for military surveillance, stratospheric airships for scientific research, and even orbital airships for exploration of other planets (Hochstetler 1-4).

Works Cited

Archbold, Rick. *Hindenburg: An Illustrated History* New York: Warner Books, 1994.

Print. Origin: Print book. Purpose: It tells the full story of the Hindenburg as well as short stories about other dirigibles of the day and illustrates them fully (great artwork!) Value: The illustration of the internal structure of the Hindenburg was superb. It gave me a good sense for how rigid airships were built. Limitation: Focus on rigid airships; didn't provide any information about blimps or semi-rigid airships.

"Army & Navy: Biggest Dirigible." *Time Magazine*. 10 (11 July, 1927). *Student*

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<http://www.time.com/time/magazine/article/0,9171,929303,00.html?artId=929303?contType=article?chn=us>.

Origin: Online Time Magazine article. Purpose: Public news about the USS Akron dirigible. Value: Provided basic statistics for the dirigible and the cost to build. Limitation: Precious little information beyond basic statistics.

Beaubois, Henry. *Airships : Yesterday, Today, and Tomorrow* New York: Two

Continents Pub. Group, 1976. Print. Origin: Print book. Purpose: Describes airship design and explores possible changes in the future. Value: Provided strong illustrations of almost every airship ever designed and provided a synopsis of base design for each airship type. Limitation: Diagrams did not give internal structure, showed only exterior.

Botting, Douglas. *Dr. Eckener's Dream Machine: The Great Zeppelin and the Dawn of*

Air Travel. New York, NY: Henry Holt and Co., LLC, 2001. Print. Origin: Print

book. Purpose: Describes the life of Hugo Eckener and how he was involved in and became an expert at flying airships. Value: Provided many original quotes from Eckener and other primary sources, such as Lady Hay. Limitation: This was non-fiction, but it read like a novel. It was hard to put down; very distracting if trying to find just information!

Chollet, Capt. L. "Balloon Fabrics Made of Goldbeater's Skin." *L'Aeronautique* August, 1922 (1922). October 20, 2011.

<http://naca.central.cranfield.ac.uk/reports/1922/naca-tm-172.pdf>. Origin: Web version of magazine article; typed translated manuscript. Purpose: To describe processes for making and using goldbeater's skin for lighter-than-air craft. Value: BEST primary source I've ever seen!!! Gave good, honest information from the experts of the day. I found skins G, P, and L interesting. Did you know it was illegal for awhile to use intestines to make sausage? Go figure...Airship impact on food! Limitation: Focus is exclusive and deep into one facet of subject.

Crouch, Tom D. *Lighter Than Air: An Illustrated History of Balloons and Airships*.

Baltimore, MD: Johns Hopkins University Press, 2009. Print. Origin: Print book.

Purpose: Provide general historical information about balloons and airships.

Value: Very good general source I could easily rely on to provide background information. This included successful ideas and failures, too. It had a section on scientific balloons and another on the Navy dirigibles. It had sections on almost everything. I pretty much read this one cover to cover. Limitation: Historical only, little information on modern technology or advances in airships.

Ellsworth, Lincoln and Edward H. Smith. "Report of the Preliminary Results of the Aeroarctic Expedition with "Graf Zeppelin," 1931." *The Geographical Review* (1931). *JStor*. October 4, 2011. Online Geographical Review article. Purpose: Report on latest Arctic flight of Graf Zeppelin. Value: Provided details of Arctic voyage and how Eckener dealt with the harsh conditions. Focus on scientific exploration. Limitation: As specific as the article on goldbeater's skin. No big picture.

Graham-White, Claude, and Harry Harper. *Aircraft in the Great War; a Record and Study*. London,: T.F. Unwin, 1915. Print. Origin: Print book. Purpose: Provide "old-time" information, most of which is outdated now. Value: Provided information on early balloons and military use. Limitation: Main focus was heavier-than-air craft, not airships.

Grossman, Daniel. "Airships: The Hindenburg and Other Zeppelins". 2009. (October 30, 2011). <<http://www.airships.net>>. Origin: Online Web page. Purpose: Document Zeppelins; history, design, statistics, and lots of images from the day. Value: Images and statistics on the sheds for the Zeppelins. Limitation: Little time to explore this site.

Hochstetler, Ron. "Airships for the 21st Century." *IEEE Spectrum* (October, 2010). October 4, 2011 <<http://spectrum.ieee.org/aerospace/aviation/airships-for-the-21st-century>>. Origin: Online IEEE Spectrum magazine article. Purpose: Provide update on recent developments in airship technology and explore possible future applications. Value: This article is what inspired me to write my paper about airships. I was captivated by the possibilities and when I was given this project, it

struck me to explore this further. Limitation: Focus is on current design and possible purposes, rather than current or past uses.

Prentice, Barry E. and Jim Thomson. "Economics of Airships in Northern Re-Supply."

(2004). Sept. 28, 2010

<http://www.airshipstotheartic.com/docs/pr/isopolar_eanrs.pdf>. Origin: Online paper. Purpose: Persuasive paper aimed at Canadian government. Value: On skimming through it, I was surprised by such positive statistics: they make a strong argument. Airships have an undeniable potential, especially for cargo delivery to remote areas. Limitation: Was too specific, did not specify what kinds of airships would be used for such purposes.