Post 1. Giant Airships: The Next Great History-Changing Technology?

Living under capitalism involves incessant technological change. Companies tweak their products, release new models, etc., but most of the changes are small, incremental improvements. Some, however, revolutionize lifestyles and the economy. Important new concepts become part of everyday language and change the world, as we know it. But to adopt and adapt takes decades. Careers and companies are made and broken in a wave of creative destruction, and the world before and after is so different that people can hardly imagine life before. Notable examples are printing, steam power, railroads, factory production of cotton clothing, sailing ships, vaccines, electricity, steel, plastics, the automobile, the airplane, refrigeration, movies, telegraphs, telephones, radio, TV, air conditioning, and most recently, computers, the internet, and cell phones. Growth economist Elhanan Helpman has called these history-changing inventions "general purpose technologies."

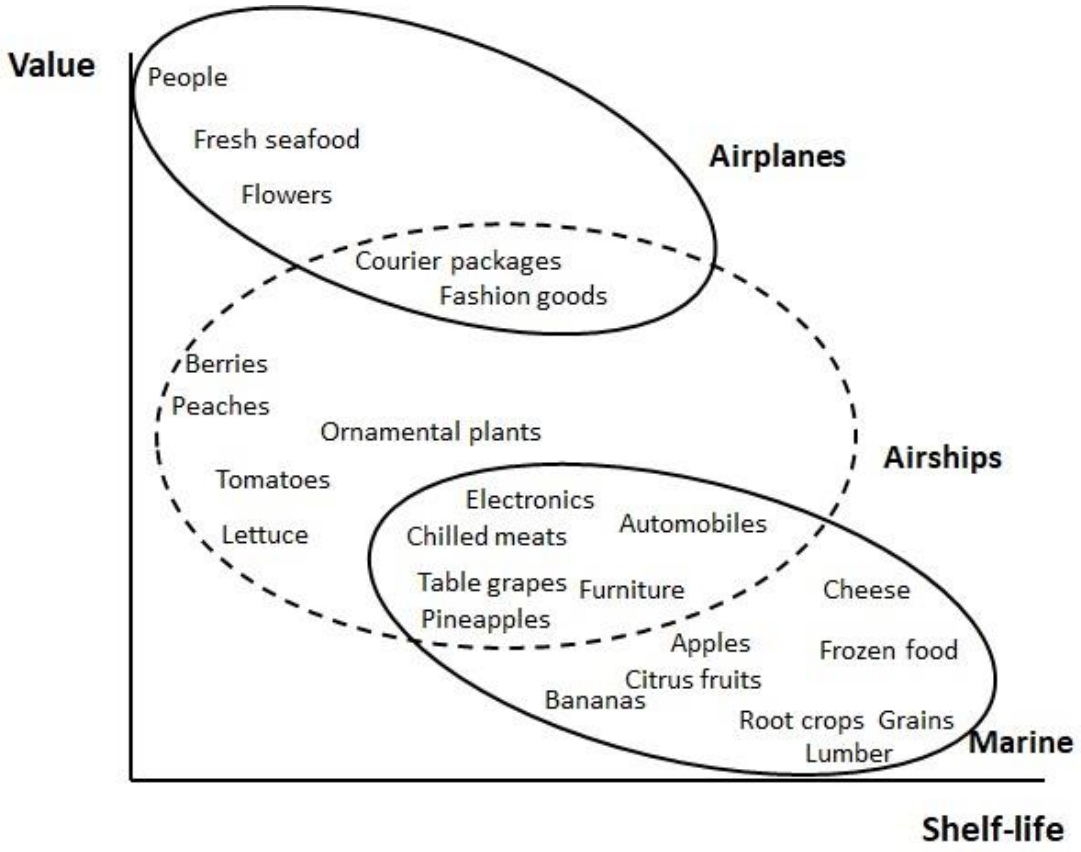
What will the next one be? Investors and inventors, CEOs and politicians are always trying to guess, and all answers are tentative. Though no one really knows, the stakes are so high that even guesswork is worthwhile. In that spirit, the claim advanced here is that giant airships for moving freight, and to a lesser extent passengers, stand ready, with a large dollop of capital investment, to become the next great history-changing technology.

The clinching argument is presented first, to lend the claim plausibility. Amidst much uncertainty about the potential size of airship markets, one stands out: intercontinental shipping. Giant airships in international shipping can hardly fail to become a trillion-dollar industry, if the expensive task of bringing them to technological maturity is surmounted.

By volume, most intercontinental trade is carried on ships. According to UNCTAD's *Review of Maritime Transport*, over 10 billion tons were shipped in 2017, by over 50,000 merchant vessels, amounting to over 60 trillion ton-miles of shipping. Freight rates are often as low as 1¢ per ton-mile or less. However in terms of value, some 40% of world trade is transported by air. World air freight was about 1.32 billion ton-miles in 2017. Airplanes are expensive at $1 per ton-mile or more, but planes go hundreds of miles per hour, compared to 12-15 miles per hour for ships. Trans-oceanic shippers face a stark choice between very fast and expensive or very cheap, but slow, with nothing in the middle.

Overland shippers face no such dilemma. They have two modes of transport, trucks and trains, that represent "middle options" that are several times faster than ships and several times cheaper than airplanes. Not surprisingly, trucks and trains capture most overland freight. If trans-oceanic shippers had such a middle option, it stands to reason that they would use it heavily. In some cases, they already try to find a middle option by using both ships and planes to move the same goods. Some Asian shippers use what is called a sea-air combination. Goods are put onto container ships and transported from China to the UAE, then transloaded on to airplanes to complete their journey to Europe. This cuts the time in half, and reduces the cost by one-third, but only a few commodities use this method. If cargo airships were available, they could cut the time by more than two-thirds and the cost to about one-quarter of current air-freight rates.

As illustrated in the figure below, cargo airships would overlap with the lower end of the airplane market for goods that are less perishable and lower in unit value. Airships also overlap with ships for their higher value more perishable products. In between are products that rarely cross oceans today because they are too perishable for ships and too low in value for airplanes. These would be an entirely new trade opportunities created by the option of cargo airships.



Adapted from: Prentice, et al. "Global Trade of Perishables in the 21st Century: The Case for Giant Airships", *Transportation Research Forum*. Proceedings Issue: 45th Annual Meeting (2004)

Engineering estimates suggest that giant airships could cost below 15¢ per ton-km or even lower, and speeds of 100-150 km per hour. How big an industry would that create? Cargo airships, probably carrying at least 100 to 150 tons, could capture most of the air freight now moving much more expensively on dedicated cargo jets. Passenger jets will always carry some air cargo because it is a by-product. A good deal of the more valuable freight now moving in containers by sea would also switch to cargo airships. In addition, airships would stimulate new trade. The most obvious example is commodities that are too perishable to withstand sea shipment, such as fruits and vegetables, and fashion goods.

If only 2% of the current trade that goes by sea, went by such giant airships instead, it would take about 10,000 busy cargo airships to carry all that freight, and their revenues might be about $200 billion. If these giant airships (100 to 150 tons lift) cost $100 million apiece to build, in line with some estimates, the replacement cost of the world's giant airship fleet would be $1 trillion. Such an airship industry might employ a million people in operations, loading and unloading airships, as well as running airship ports, managing transactions, and building the airships.

And it could get even bigger. Again, on land, *most* freight by value moves using the middle options, trains and trucks. That makes 2% seem conservative, and a figure ten times larger seem

plausible. A $200 billion trans-oceanic airship freight industry would be big news. A $2 trillion cargo airship industry would change the course of history, affecting everything, from commodity prices, to supply chains, to international trade patterns, to city systems and urban geography, to the industrial composition and interdependency of all sorts of national economies, to patterns of human settlement, to growth rates at the economic frontier, to wages, to the prevailing rates of return on capital, to the opportunities of less developed countries to rapidly close the gap, to the environment and the flourishing of wild nature.

And all that is on the strength of just one market, trans-oceanic shipping. Giant airships would have many other uses, too.

Over the next few months, there will be biweekly posts at this blog that explain and expand on how giant rigid lighter-than-air airships can change the world of transportation in the coming years.

The next four posts deal with airship technology. The second post discusses the basic principles lighter-than-air lifting gases and aerostatic flight. A third post addresses the drag equation, and why airship transport is cheaper than airplanes, but faster than ships. A fourth post considers the outstanding challenges facing an airship renaissance, of which the most important is the difficulty of managing and financing the innovation process in the absence of downward scalability. The fifth post explains the structural differences between non-rigid airships (blimps), hybrid airship/airplane combinations, and giant lighter-than-air rigid airships.

In the sixth post the history of the early 20th century rigid airships is reviewed. Though they lacked many of the complementary technologies that are available today, the achievements of these early pioneers are impressive.

Next, attention turns to airship markets. Introducing that theme will be a post on giant airships as the sixth major mode of transportation, alongside motor, rail, water, pipelines and airplanes. Reasons are presented why such a future is highly desirable.

Some posts comparing airships to other major modes of transportation may help readers to grasp imaginatively what airships' potential capabilities and inherent limitations are, while highlighting myriad potential markets. A comparison of airships and airplanes is offered to emphasize their different flying experiences, and to explore potential passenger applications. Another post compares airships to ships, in particular 19th century sailing ships that needed little or no infrastructure to explore distance remote, undeveloped places. The last post in this series explores the likely evolution of competition and complementarity between airships and trucks.

The posts that follow the discussion of capabilities take a closer examination of the market as glimpsed in this post: the great intercontinental shipping market. Giant cargo airships have a vast and easy opportunity to capture enormous business thanks to their inherent capability to bridge the service gap between container ships and dedicated jet cargo planes. One post will explain how the demand for intercontinental shipping is derived from patterns of international comparative advantage and product characteristics such as perishability and value-to-weight ratio. From this analysis come conclusions about what can be known or safely guessed about intercontinental shippers' willingness to pay for delivery speed. Turning to the supply side, another post explains how huge fleets of giant airships would serve this demand by being organized into "railroads in the sky," shipping goods between trade hubs around the world.

From there, further topics beckon, such as the corporate finance conundrum of getting investment to develop a technology that promises huge returns but requires much larger upfront commitments to get to the minimum viable product stage. The helpful role that governments could play in the emergence of a major new transportation technology. The use of cargo airships to move very large project cargo. An exploration of the geopolitical ramifications of the airship renaissance. The application of cargo airships to alleviate natural and manmade humanitarian disasters. But by that time, readers may also be suggesting topics that should be studied, too.

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