Supersonic Transport and its Sustainability in the Future

How a Challenge-Ridden Technology Can Achieve Global Adoption

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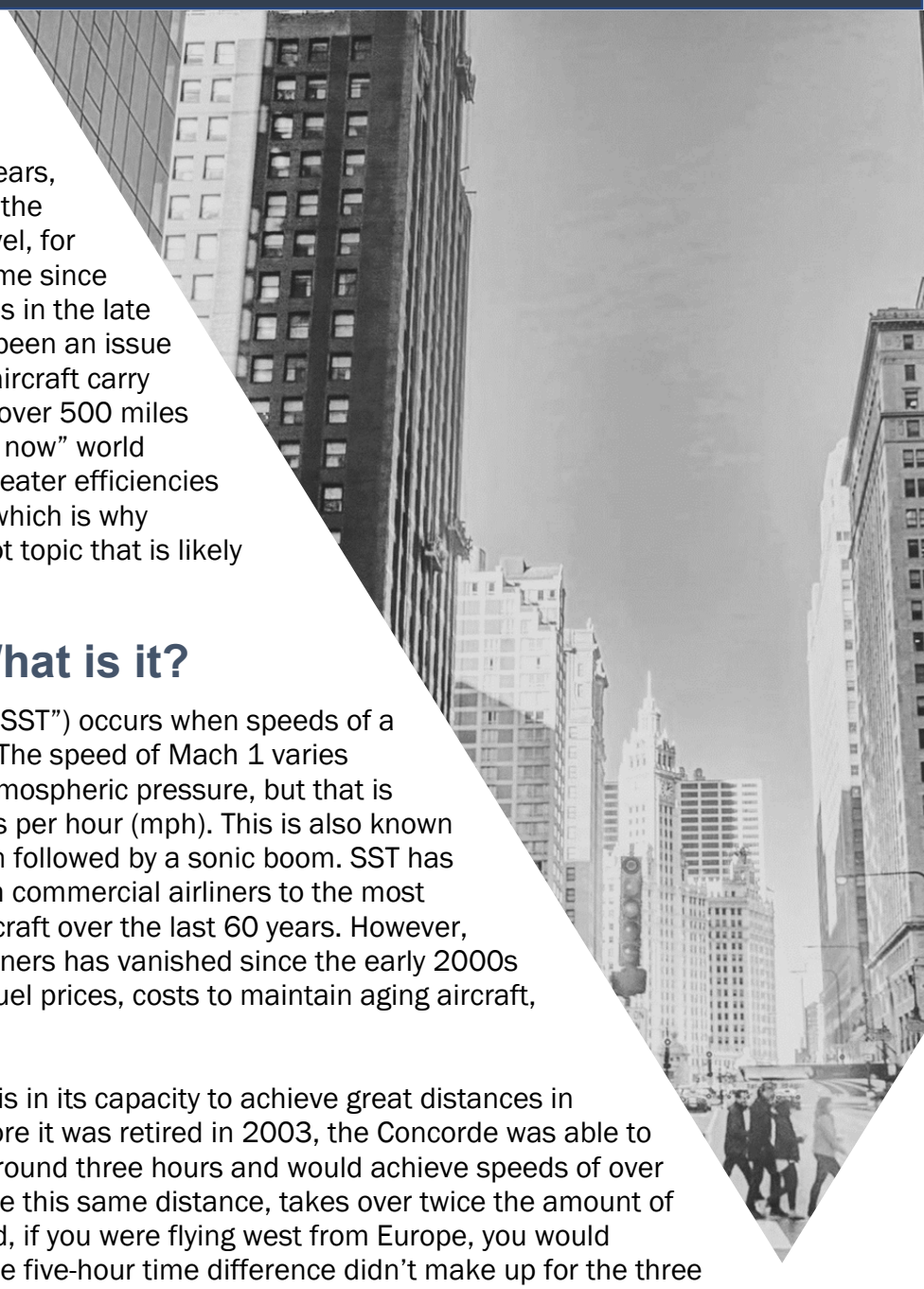


Introduction

Transportation, apart from advanced logistics technology over the last 50 years, has remained mostly stagnant across the globe. The speed at which aircraft travel, for example, has mostly remained the same since the introduction of jet-powered engines in the late 1940s. For the most part, this hasn't been an issue for most passengers, as modern-day aircraft carry hundreds of passengers at speeds of over 500 miles per hour. In today's ever busy "want it now" world though, passengers are demanding greater efficiencies for travel in both speed and comfort, which is why supersonic transport is becoming a hot topic that is likely here to stay.

Supersonic Travel – What is it?

Supersonic transport (also known as "SST") occurs when speeds of a "vessel" achieve Mach 1 (or greater). The speed of Mach 1 varies depending on the temperature and atmospheric pressure, but that is typically achieved at around 760 miles per hour (mph). This is also known as the "speed of sound", which is then followed by a sonic boom. SST has been around in various iterations from commercial airliners to the most ubiquitous fighter jets and military aircraft over the last 60 years. However, similar technology for commercial airliners has vanished since the early 2000s due to factors including increases in fuel prices, costs to maintain aging aircraft, and the attacks of September 11.

The main benefit of supersonic travel is in its capacity to achieve great distances in shorter timeframes. For example, before it was retired in 2003, the Concorde was able to get from New York City to London in around three hours and would achieve speeds of over 1300 mph. A typical airliner, to achieve this same distance, takes over twice the amount of time. In fact, with this incredible speed, if you were flying west from Europe, you would technically arrive before you left, as the five-hour time difference didn't make up for the three hours of travel. Faster travel also means aircraft can be used more frequently, allowing for more flights.

The sustainability of SST has been called into question, however, particularly as it relates to environmental concerns, rising fuel costs and, most practically, ensuring these aircraft are equipped with durable tires capable of safely reaching 200+ knots before takeoff. Much like driving a car quickly, fuel is typically lost at a rapid rate once higher speeds are achieved. For example, in some supercars it is normal for the car to run through an entire twenty-gallon tank in twenty minutes if it is traveling at 200 mph. Not as extreme, but this also happens when aircraft are traveling at over 800 mph and decreases its total range to approximately 1/3 the distance of a standard jet airliner.

Supersonic Transport's Comeback

Despite some commercial reticence at the turn of the 21st century, the concept of SST is actively becoming a reality again, as companies attempt to gain a competitive advantage by mastering this technological capability. In order to fully understand the reemergence of SST, it is necessary to understand some of the major market players and industry developments.

The two companies we highlight below are making substantial headway in bringing supersonic travel back to the 21st century and demonstrate both some of the possibilities and challenges with attempting to advance updated technology to the public.

Boom Supersonic

Figure 1: Boom Supersonic's Overture, Copyright © 2022 Boom Supersonic

One company working to improve the original Concorde is Boom Supersonic. The company's CEO, Blake Scholl, is aspiring to be the first private company to develop and build a supersonic airliner. The new aircraft has been named Overture, and it is set to cruise at an altitude of 60,000 feet with an achieved speed of Mach 1.7 while carrying its 65-80 passengers. Boom Supersonic is unique due to their prioritization of affordable supersonic travel. The highest ticket price for an international trip on one of these supersonic jets is estimated to cost $5,000. While not cheap, Scholl's goal is to make supersonic travel more accessible rather than simply a luxury reserved for the wealthy. This may ultimately be possible - the desired ticket price for consumers is comparatively less expensive than in the past, and the estimated cost to build one Overture aircraft is around $200 million. To put that figure in perspective, the most ubiquitous plane today costs approximately $104 million, which puts the $5,000 figure in line with this doubling of the conventional airliner's cost. Still, the company is currently experimenting with a single-seater test plane to uncover any unexpected additional costs before providing price guarantees. Boom hopes to have a preliminary model in the air later this year.

While the development of Overture is only in its early stages, it has already gained the attention of various airlines. In 2021, the airway giant, United Airlines, placed an order with Boom for 15 Overture aircraft. Once Boom Supersonic proves that it can meet United's safety, operating, and sustainability requirements, United has stated that they will consider ordering another 35 airplanes from Boom. By 2025, Boom and United have planned to begin Overture's rollout.

By 2026, Overture is estimated to take its first flight after three years of flight testing. Boom has also estimated that Overture will begin passenger travel in 2029 and use 100% sustainable aviation fuel for its flights. Along with United Airlines, American Airlines announced in August of 2022 that they have also placed an order with Boom for 20 supersonic aircraft with the potential to order 20 more. If the trends continue, we will be able to see whether Boom's promises are realized,

with the diminution of flight time from New York to London being achieved in three and a half hours versus the typical seven-hour flight time.

Skunk Works

Another company gaining the attention of big-name airlines is Skunk Works. Skunk Works is a California aircraft design studio that is developing their own version of a supersonic airline called X-59, with the focus to mitigate the "boom" sound effect caused by the high speeds reached. Skunk Works' unique aircraft shape is what reduces the volume of sound from a "boom" to a quieter "thump" that can barely be heard amongst pedestrians. Two Lockheed Martin employees, Mike Buonanno and Mike Richardson, are spearheading the project along with NASA to construct a plane that can fly double the speed of a current airliner. NASA awarded Skunk Works a $247.5M contract for the preliminary design of its X-59 in 2016, with manufacturing beginning in 2018. In 2019, NASA and Skunk Works completed a critical design review for the X-59. Recently, structural tests have been completed, and the X-59 has been delivered to Palmdale, CA where its major systems and subsystems will be installed. Lockheed Martin is hoping to fly the X-59, for the first time, later this year.

Figure 2: "X-59 Quiet SuperSonic Technology X-plane, or QueSST" by Robert Sullivan used under Public Domain Mark 1.0

Sustainability of Supersonic Transport

Innovation and traveling at high speeds are only worthwhile if there are ways to viably sustain the development. Despite the allure of SST, there are consequences associated with this technological capability. Chiefly, there is a significant environmental impact, including fuel consumption and emissions. Other inhibiting factors like noise pollution, cost-inefficiencies and current policies only add to the environmental challenges. After understanding these challenges, ideas will be advanced to understand how sustainability can still be achieved and offer guidance on how industries with comparable obstacles can pivot while meeting their business and environmental aims.

Limits and Challenges to Sustainability

Fuel Consumption and Emissions

One of the main challenges of SST is the amount of fuel it requires. In the current global market with intense fuel shortages, systemic shocks, and regular price hikes, this issue is only more acute. This volatility presents a real challenge in operating any fuel-powered mechanism of transportation, let alone one that guzzles five to nine times the amount of fuel needed per seat than a regular jet airplane.[1]

[1] https://theicct.org/new-supersonic-transport-aircraft-fuel-burn-parity-or-environmental-parody/

Beyond the financial and practical concerns, fuel emissions also have a massive impact on our environment and are known to be a large contributing factor to global warming. Increased fuel consumption leads to increased fuel emissions; airplanes emit their fumes directly into our upper atmosphere, where these emissions linger and have a greater warming effect than if equal amounts were released at the surface of the Earth.[2] One of the chief international concerns around the environmental effects of SST is the carbon dioxide release. Information provided by the Intergovernmental Panel on Climate Change states carbon dioxide can survive in the atmosphere for 100 years. With global aviation's carbon dioxide emission levels rivaling that of some industrialized countries, this presents a major concern for the air we breathe.

These figures, therefore, must be considered when analyzing the limits and challenges of SST and preparing for its future. If the aviation industry seeks to reintroduce this technology, it begs the question: Is the potential effect on our environment worth the benefit of supersonic travel? Additionally, with the projected passenger traffic growth, will the industry be timely in subverting the severe environmental damage that, under current conditions, will likely result?

Noise Pollution/Sonic Boom

Another drawback to SST is the sonic boom. The sonic boom, as defined by the Air Force, is "an impulsive noise similar to thunder…caused by an object moving faster than sound – about 750 miles per hour at sea level." This sound is created when an aircraft generates a shock wave along its flight path, which may take place when an aircraft changes direction or pulls up.

This phenomenon has been one of the larger social pains since the advent of the technology. The most heavily impacted regions, including Canada, Germany, Iraq, Ireland, Israel, Romania, Turkey, and parts of the United States, could be exposed to between 150 and 200 sonic booms per day, or up to one boom every five minutes over a 16-hour flight day.[3]

Though some might be willing to tolerate the frequent boom sounds, exposure to sonic booms has been linked to sleep disturbance, learning delay in children, mental health problems, and even heart disease for both humans and animals.[4] The data collected around earlier attempts of supersonic transport in the 1960-70's led to the FAA ban on civil overland supersonic flight in 1973. It is likely for this reason that Skunk Works' efforts to mitigate the boom sound are so compelling to major airlines, and why it culminated in the investment from NASA.

Policy

The negative impacts on the environment and public are some of the main reasons legislation around SST is so restrictive. FAA regulation restricts the operation of civil aircraft at speeds greater than Mach 1, unless authorized by FAA.[5] These restrictions are only within the United States, which could create tension between other countries that seek to implement SST within their own borders. This regulatory landscape will likely make any progress in the area disjointed and difficult, precluding global entities from working in unison to create plans, establishing restrictions and

[2] https://www.gao.gov/products/rced-00-57; https://www.gao.gov/assets/rced-00-57.pdf
[3] https://theicct.org/publication/noise-and-climate-impacts-of-an-unconstrained-commercial-supersonic-network/
[4] https://theicct.org/the-environmental-and-health-impacts-of-a-new-generation-of-supersonic-aircraft-could-be-immense/#:~:text=Emerging%20commercial%20supersonic%20aircraft%20could,on%20Clean%20Transportation%20(ICCT).
[5] https://www.ecfr.gov/current/title-14/chapter-I/subchapter-F/part-91/subpart-I/section-91.817

standards, and aggregating valuable data. Practically, it's challenging to understand how SST might develop when allowances are made for over open water travel, but not over land. On top of the environmental and noise pollution issues, the policy arena has only exacerbated the challenges posed for industries seeking to move forward.

Costs to Operate

The thought of traveling from New York to London in a few hours is sure to excite any traveler, but few travelers will be able to afford it, even if companies like Boom are able to decrease prices. With the desire for travel increasing following the pandemic, ticket prices have soared. These spikes in prices have deterred many eager travelers from travelling at all, even without supersonic capabilities.[6] This practical issue would only grow for SST, as ticket prices would reach astronomical levels, unless/until the technology can be replicated quickly using economies of scale to flood the market with supersonic offerings. Even with the current purchase orders of major airlines, this would likely not meet the needed capacity to achieve major price decreases.

Putting aside the direct cost to the consumer, the total cost to develop a supersonic jet will greatly supersede that of subsonic planes. The type of material traditionally used to build traditional commercial airplanes is aluminum, a cheaper resource that will not suffice for supersonic travel. These jets will be flying at altitudes over 20,000 feet higher than normal, necessitating materials that can withstand the hotter temperatures and different atmospheric pressures. Stainless steel, which is considerably more expensive than aluminum, would need to be used to successfully fly at these altitudes.

Ways to Make this Sustainable

While the adverse environmental, financial, and social affects present real challenges, companies are finding creative ways to make progress in producing viable solutions. To address noise-pollution, for example, companies are making new supersonic aircraft designs with low- to medium-bypass turbo-fans, rather than pure turbojets. This is significant, as these turbofans have substantially fewer noise impacts. With so many international hubs that would potentially be impacted by SST noise-pollution, this adjustment would be a welcome benefit to both pedestrians and legislators.

Relatedly, there is a shift in the policy community as U.S. congressional leaders are beginning to reconsider their restrictive posture to SST. The conversation is now primarily focused on advancing this type of travel, rather than stonewalling it, but in a way that legislates its sustainability. This direction is shown in Section 181 of the FAA Reauthorization Act of 2018 which specifies that "the FAA administrator exercises leadership in the creation of federal and international policies, regulations, and standards relating to the certification and safe and efficient operation of civil supersonic aircraft."[7] Ultimately, to make this type of transport sustainable, standards that safeguard the industry as a whole should be in place before a substantial amount of funding is spent on the development of these jets.

[6] https://www.cnbc.com/2022/10/05/high-inflation-has-many-americans-tweaking-their-holiday-travel-plans.html
[7] https://www.faa.gov/about/plans_reports/congress/media/FAA_Leadership_Civil_Supersonic_Aircraft.pdf

Implementation Strategy

With the reemergence of SST, management consulting needs in the industry will invariably increase to help navigate business and finance requirements, government regulations, and environmental concerns. Stakeholders looking to enter the SST landscape should conduct well-rounded research on the key factors of the industry, like the aforementioned research. From 1975, research, resources, jobs, time, and effort have been poured into SST and its capabilities. With the impressive benefit of significantly shorter travel, it is not without its challenges.

An understanding of the workings, challenges, and opportunities for this technology are crucial, but the strategy needed to implement it must be optimized to see it come to fruition effectively. The ability to leverage SST technology will also require consideration and input from a multitude of stakeholders. Companies that seek to develop this type of transport should present their case, as we have above, highlighting the many benefits of SST to the government and consumers, as well as the challenges that impede its implementation. Governing bodies should also be involved in this process, so companies are positioned to produce well designed, environmentally-sound and regulatorily approved modes of SST.

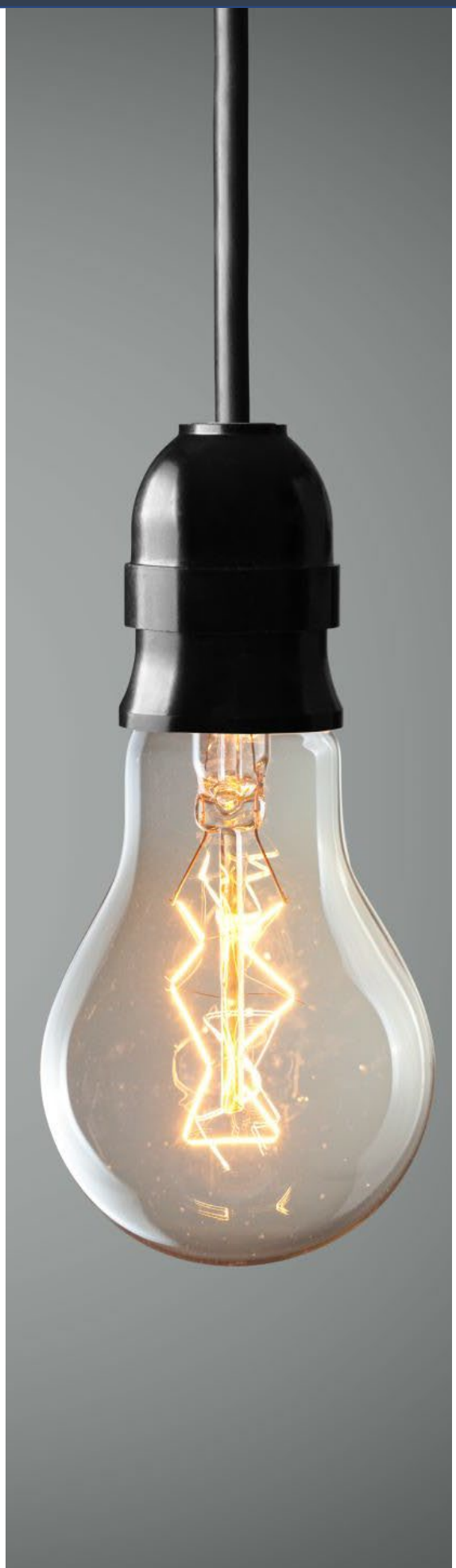
This will require industry and government to work together to implement the technology for the greater benefit for all. Unfortunately, it's evident that both sides often struggle to sit at the table and understand each other's needs. This might emanate from the business stakeholders failing to appreciate the regulators' concerns for those they serve, or from regulators finding it difficult to fully conceptualize industry trends and phenomena.

McBride's experience and expertise in understanding and mapping the needs of both industry and government clients helps it serve as stakeholder bridge-builders and trusted advisors. Once achieving that desired alignment, McBride will work towards the creation of a plan that achieves the goals of industry and government; specifically, providing efficient travel while reducing impacts to the environment, promoting economic growth, and maintaining a competitive technological edge.

Conclusion

Our newly globalized world will need to work together to make SST viable and sustainable for the future of travel. It will take the monetary, physical, and intellectual resources of many to develop a robust jet that factors in the health of our globe, as SST can only be made sustainable through a multi-lateral approach that takes environmental, social, and financial impacts into account.

This will require manufacturers to weave many considerations into the design, development, and operability of these jets. It will also require proactive collaboration with governments and businesses to pass preemptive regulations together that both enable this new technology while ensuring safe standards and procedures are followed. Between business and government are firms capable of implementing those partnerships seamlessly, so everyone can achieve their mutual modernizing aspirations. One nation alone will not be able to accomplish this alone – this must be a global effort.



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