How Consumer Groups Promote Sustainability in the Airline Industry:
A Case Study on Biofuel

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

This study will examine how consumers pressure airlines into adopting sustainable business practices, and will use the "social construction of technology" (SCOT) framework to do so. Most modern airline companies employ a wide range of sustainability practices, both in an attempt to reduce emissions and to brand themselves as eco-friendly. These practices range from smaller scale changes like using recycled materials and sourcing locally grown food for in-flight meals, to larger scale, aviation-specific technologies such as alternative fuel sources, low-emission takeoff and landing procedures, and increasing the aircraft's aerodynamic efficiency. In this report, biofuel will be used as a sort of case study to illustrate how the various stakeholders compete for control over emerging sustainability technologies, and how each criterion for a "successful" new aircraft technology gets cemented into the prevailing design. The other aforementioned technologies and practices will also be briefly analyzed to show how an overabundance of purported solutions can lead to disillusionment and loss of faith by consumers.

STS Framework

As Pinch and Bjiker (1987) lay out in their seminal work, the first step in employing the SCOT model is "the demonstration that technological artifacts are culturally constructed and interpreted," or revealing what they refer to as an artifact's interpretative flexibility. To do this, the relevant social groups that will interact with the technology must be identified, and each group's respective construction of the artifact must be analyzed to understand how different criteria vary in importance from one group to the next. Additionally, the conflicts that arise between the various social groups' interpretations should be looked at to see how each group's values become embedded into the design of the new technology. Eventually, the interpretative flexibility of a design will gradually decrease until one model prevails. Identifying this collapse of interpretative flexibility is the final step of the SCOT methodology, and typically occurs via one of two “closure mechanisms.” Either a) the relevant social groups deem the current design as an adequate solution, and thus new designs are no longer made (what Pinch and Bjiker refer to as “rhetorical closure”); or b) the problem itself becomes redefined so that the existing design is now deemed a success under the newly defined constraints (called “closure by redefinition”).

The SCOT model will be used to understand why the airline industry has been sluggish to adopt biofuels as an industry standard by considering the interpretive flexibility of biofuel from the perspective of three relevant social groups: environmentally-conscious consumers and NGOs, aviation regulatory bodies, and the airlines/airline alliance groups.

Background

Innovations in aircraft efficiency are obviously motivated, in part, out of economic self-interest on behalf of airline companies, but it’s important to note that such advancements are also inextricably linked to prevailing social norms and public pressures. As Lee and Mo note in their 2011 study of technological innovation in the aviation sector, some of the most significant improvements to turbine efficiency of the last half-century were made during the 1960s, a time in which widespread mobilization of environmentally-minded activists and organizations occurred. In comparison, the improvements made during the 1970’s, a decade that saw major shocks in oil prices in both 1972 and 1978, were little to none. This shows a clear precedent of social movements having a tangible effect on the aviation industry, and that economic factors alone do not lead to significant improvements in turbine efficiency.

Existing Support Systems for Biofuel

Today, as awareness surrounding global warming has grown and more individual consumers have started leveraging their spending habits as a means of advocating for the causes they support, airlines have been remotivated to research and implement emission-reducing technologies, and generally adopt other popular sustainable business practices. There are thousands of new technologies that are being researched as a way to increase a turbine's efficiency, even by fractions of a percent, but the clear front runner in terms of reducing overall greenhouse gas emissions is biofuel, which boasts emissions reductions of up to 85% under idealized conditions (Bailis & Baka, 2010). Biofuels for jet engines are produced using a wide variety of processes, but the term "biojet fuel" generally refers to any fuel produced by converting plant-matter or organic waste into synthesized hydrocarbons. The biojet fuels that have the smallest carbon footprint (or greatest carbon offset, in some cases) are those that grow biomass feedstock on formerly agricultural or pastoral land, as a method of reclamation (Bailis & Baka, 2010).

These proven benefits of biofuel have led to significant action being taken by government agencies. In 2011, the U.S. Department of Energy and the Navy pledged $510 million to stimulate private sector production, and the USDA similarly set aside funds "to address feedstock development through a $161 million innovative program" (Wang, Tao & Markham, 2016). There are also many rebates available such as the California Air Resources Board's LCFS, which can amount to a $0.99/gal credit, or the EPA's Renewable Identification Numbers, which awards varying credits based on the type of renewable fuel used, and which some estimates put at a credit of $3.06/gal (Lane, 2019). Clearly, regulatory mechanisms are in place to facilitate airlines' transition to biofuels.

In 2008, some of the largest aviation companies (United, Jet Blue, Virgin, Lufthansa, Boeing and Airbus) formed the Sustainable Aviation Fuel User Group (SAFUG) and, in recent years, increased pressure has seen the group grow to include 33% of total commercial aviation fuel demand (SAFUG, 2020). Today, almost all major players in the aviation industry have pledged by 2050 to have reduced their emissions by 50% relative to 2008 levels (Zumbach, 2020), with many more airlines pledging net zero emissions by 2050 (Topham, 2020). The public demands it, governmental organizations are willing to fund it, and airlines say they're willing to implement it and yet, as of 2018, less than 0.1% of total aviation fuel consumption was biofuel (Le Feuvre, 2019). So why isn't biofuel being used in more flights? The problem arises out of each group's conflicting interpretation of the new technology.

Analysis with SCOT Model

Airlines as Stakeholders

The decelerating rate at which aircraft engine efficiency has improved in recent years has led to aviation fuel burn becoming the "fastest growing, potentially significant source of greenhouse gas emissions" (Lee & Mo, 2011). Consequently, public approval of air travel has taken a hit with a year-over-year decrease in domestic traffic of 10% in 2018 (Kim & Son, 2021), and 22% of travelers from the US and Germany reporting they reduced their air travel out of environmental concerns (UBS, 2019). Airlines are conscious of this growing trend of "flygskam" (a popularized Swedish term that translates to "flight-shaming"), and are working to remedy their public image. But the airline industry is characteristically sluggish in adopting new technologies, with time frames of 50 years from a technology's development to implementation not at all uncommon. As a stakeholder, airlines' primary demands of biofuel in order of importance are that it be:

1. Economically feasible
2. Reduce emissions to a level that will regain public approval
3. Have an adequate production infrastructure to ensure their demand can be met

Simply put, current biofuels are not economically feasible without significant subsidies. Kerosene jet fuel prices have fluctuated around $1-2 per gallon over the last decade, whereas current estimates for biofuel, including full production and refinement costs, are around $5 per gallon (Wang, Tao & Markham, 2016). The bulk of the cost for biofuel comes from production and transportation, as the infrastructure to support biofuel is virtually nonexistent. Most airports have direct pipeline access to traditional jet fuel, which significantly reduces the cost of transportation. On the other hand, the biofuel plants that do exist are typically set up near the source of biomass or waste that they are converting. Therefore, most biofuel plants have to haul off their product by the truckload and either deliver it directly or via rail to the airports (Doliente, Narayan, Tapia, Samsatli, Zhao, & Samsatli, 2020). Creating the additional pipeline necessary to connect biofuel plants to the existing jet fuel infrastructure is a significant investment and, so far, biofuel suppliers have been forced to rely on slow, expensive transportation methods.

As stated earlier, a primary motivator for airlines to reduce emissions is public pressures (of course this is an economic concern as well, as public disapproval means less customers, but it can be argued that this is simply consumers pushing for social change via their spending). So, the biofuel that is implemented must be easily marketable as environmentally friendly. This is where airlines become dependent on NGOs, as airlines aren’t trusted to verify the reduced environmental impact that their biofuel has. Instead, consumer groups are needed to work with airlines to either approve or disapprove of an airline’s biofuel utilization. In exchange, the NGO has the power to persuade consumers to use certain airlines that have proven to be more committed to sustainability than others. This relationship will be explored in more detail in the following section on NGOs.

Another reason why airlines have been hesitant to jump on biofuel is the lack of production. In 2017, domestic airlines consumed ~17 billion gallons of fuel (NREL, 2016), a significant amount compared to the global consumption of ~90 billion. From these estimates, assuming biofuel would be used in a 50/50 blend with standard jet fuel, the biofuel production capabilities of the U.S. could only reach one tenth of the required volume, as of October 2018 (Lane, 2019). This calculation comes with the caveat that all of the U.S. plants stop producing biodiesel and other biomass products, and focus their entire output on biojet fuel production. So, in reality, there needs to be somewhere between ~20-30 times the existing biojet fuel production capabilities to fully meet demands.

NGOs and Eco-Consumers as Stakeholders

As mentioned in the previous section, consumers have become very aware of the greenhouse gas contributions of air travel, with individual consumers who pledge to only purchase goods responsibly (known as “eco-consumers”) becoming more commonplace. Unlike airlines, consumer groups are quick to take action, and their demands are less nuanced than those of the airlines:

1. Switch to a biofuel that has a significant reduction in emissions immediately
2. Increase the cost of flying so that ticket prices accurately reflect the environmental impact

Although it may seem like being environmentally friendly is an inherent quality of biofuels, this is not the case. The study done by Yale researchers Bailis and Baka (2010) found that the impact on emissions of switching to biofuels can range from and 85% decrease in emissions to a 60% increase in emissions, depending on if the land used to grow the feedstock is reclaimed agropastoral land or newly cleared forest. A recent publication by an Austrian NGO, the Finance and Trade Watch, stated that “many agrofuels (notably maize and sugar cane) offer negligible emissions reductions” (Heuwiser, 2017) and that some sources, such as palm oil, which has detrimental effects to the rainforest ecosystem when harvested, can produce much higher emissions than even traditional kerosene fuels (Ranum, 2019). So, a key criterion for NGOs is that airlines don’t just start using any biofuels, but specifically biofuels that have the most net reduction in emissions.

Of the largest and most influential groups that have advocated for the industry-wide adoption of biofuels are the Roundtable on Sustainable Biomaterials (RSB) and the Sustainable Biofuels Consensus (SBC). The RSB has nearly 50 member organizations that range from small growers and producers, to chemistry organizations, to end-user and investor groups (RSB, 2020). With a varied and interconnected base of contributors, the RSB has taken initiative to create a comprehensive set of criteria for evaluating different types of biofuel, called the “RSB Certification System”. This system allows airlines to prove to consumers that their biofuel is both unharmful to the environment and produced in a manner that adheres to human rights guidelines, with backing from a reputable source.

Another example of NGOs working alongside airlines is the previously mentioned Yale study by Robert Bailis and Jennifer Baka, which was funded by the Boeing Corporation through its membership with SAFUG. The same team published another study a year later under the same funding which emphasizes the need for air travel to become less of a common commodity and more of a luxury (Bailis & Baka, 2011). Similarly, Magdalena Heuwiser, a contributing author to the Finance and Trade Watch, cites the massive subsidies given to the aviation industry in the EU (up to $50 billion USD annually) as a key contributor to the resistance towards adopting biofuels (Heuwiser, 2017). Many NGOs lay out similar plans of increasing ticket prices as a way of throttling total global air travel, and redirecting government subsidies towards the creation of biofuel infrastructure and refinement plants.

Government Agencies as Stakeholders

Government agencies don’t have one cohesive construction of biofuels. Rather, they share similarities in their construction with both NGOs and airline (understandably, since all government agencies represent and are heavily lobbied by both groups). As such, there’s no point in attempting to put together a list of their demands of biofuel. Instead, their role as a stakeholder acts more so as an accelerator; if either group, NGOs or airlines, gains more power in enforcing their construction of biofuel onto the present landscape, then government agencies are used to push that enforcement further and drive that group’s design into the accepted model.

Closure

Clearly, the technology of biofuel is far from reaching the closure stage. As shown above, each group has different constructions of the technology and, moreover, the constraints that they each require of biofuel are somewhat at odds with each other. Airlines are moving towards biofuel, but at an extremely sluggish pace and towards many types of biofuel that are not quite as environmentally friendly as they may seem. They aren’t going to put money into supporting biofuel infrastructure until it’s clear that fossil fuels have been exhausted as a reliable source of fuel, unless the public orchestrates a large-scale boycott or persuades the regulating agencies to place more severe taxes on fossil fuels/award larger subsidies to biofuels. On the other hand, NGOs know that the types of biofuel necessary to see significant reduction exist already, but are hindered by their lack of financial bargaining power when compared to the aviation titans. Both are at an impasse.

From historical context, it seems unlikely that a pie in the sky, ultra-cheap biofuel source will be discovered that becomes the obvious economic choice for airlines, without subsidies, and equally unlikely that NGOs will stop pushing feverishly for improvements if the airlines continue to use subpar biofuels in limited quantities. Therefore, rhetorical closure will probably not occur in the near future and, instead, biofuel will reach closure by redefinition. This means that, eventually, the regulating bodies will push back the goalposts when many of the goals laid out in the last decade go unmet in the proposed timeframes. NGOs will not accept the airline's failure lightly, but they will have no choice but to also redefine their demands of biofuels to a level that the airlines will actually attain.

This closure mechanism has already occurred in many other sustainability technologies for aviation. As outlined by Peeters, Higham, Kutzner, Cohen, & Gössling (2016) in their work on how technological "myths" can stall climate policy for aviation, time and time again airlines bring up new developments that are claimed to be a major breakthrough in emissions reduction, and set goals of X number of emissions reductions in Y years. Yet, ultimately very few of the laid-out plans end up being achieved. Not only can this stall climate change policy for aviation, this can lead consumers into feeling a sense of disillusionment that anything reported as a potential fix for air travel-related pollution is simply a hoax, and that sustainable aviation in itself is a pipe dream. This recurring cycle has led to large portions of the public not trusting biofuel as a reliable, truly green fuel source, and has even led some to question its safety (Filimonau, Mika, & Pawlusiński, 2018).

Discussion

Many proposed solutions to aviation-related pollution are simply impossible, be it for economic reasons or others, but biofuel is not one of them. There are significant economic barriers to the widespread use of biofuels by airlines, but they are not insurmountable. Although pipeline infrastructure is severely lacking, major reductions in kerosene jet fuel consumption can be achieved fairly quickly. Because an enormous amount of air traffic goes through a few major U.S. hubs (Los Angeles, Atlanta, Chicago, New York and D.C.), focusing on providing robust biofuel delivery systems to these five airports could have a significant, and immediate, impact on distribution.

Production, though, is a bit harder to tackle. There is enough biomass supply that comes from sustainable sources already in operation, but the major problem is refinement. Because there are so many different methods of refinement and new research is constantly coming out, there is no clear consensus on one method that should be used nationwide. Algae was thought to be the solution, with hundreds of millions of dollars of venture capital going to companies researching algal fuel oil extraction methods between 2005 and 2012, but the algae biofuel bubble popped around 2014 and most of those companies have either disbanded or changed focus (Wesoff, 2017). As opposed to venture capitalists with a herd mentality dumping money into a scientifically infeasible product, a better solution is for government agencies to redirect some of the billions of dollars in subsidies that go to airlines every year towards smaller companies that work on biofuel refinement and production from biomass. Create a committee advised by industry experts and direct cash flow to a number of different production methods so that they can get off the ground. Once running, the technique(s) with the most financial merit will become obvious after some time has passed, and the lesser techniques will still have produced a substantial amount of biofuel in the interim.

A common counterargument is that biofuels still need significant development before they prove a viable source of actual environmental benefit. And it must be conceded that all forms of biofuel that aren't prohibitively expensive come with their own detriments to the environment. C. Ford Runge's 2010 report, published at the Yale School of the Environment, heavily criticized the Obama administration's multibillion dollar subsidies towards corn producers for biofuel, and rightfully so. Runge highlights the many devastating effects that ethanol production, particularly corn, can have on the environment, and points out how often biofuel production subsidies are easily swayed by farming lobbies. While all of his claims have merit, it can be argued that investing heavily in biofuels, even ones that are only marginally better currently, will only grow more beneficial in the future as more sustainable methods are developed and economies of scale come into effect. In short, biofuel is the only somewhat-viable solution we have today, and if a switch is going to occur eventually, it's better to begin the transition now.

Conclusion

In an era of significant sustainability advancements in renewable energies, architectural and HVAC designs, and automobile efficiencies, the aviation industry has stuck out like a sore thumb. The fairly reliable oil prices and relaxed government regulations of the last 30 years have allowed airlines to twiddle their thumbs and put decreasing emissions on the backburner while they enjoyed increasing profits and hefty subsidies, but the mounting public concern over climate change and the threat of extremely volatile oil prices looming in the not-so-distant future has finally started to turn the cogs on the lethargic mechanism that is innovation in the aircraft industry. Biofuel is the clear frontrunner for championing sustainable air-travel, but many of the production methods used by airlines today are not as green as they seem.

NGOs have been instrumental in pushing for new regulations, developing measures by which different biofuels can be evaluated, and spreading awareness through intelligent discourse of the many options being researched. If the airline industry is to achieve its goal of net-zero emissions by 2050, airlines will need to take significant steps in the next five years towards supplying biofuel to major airports, and advancing the development of lower emission biofuel generation. Also, government agencies should listen to the demands from NGOs and divert funds away from subsidizing airlines, forcing airlines to raise ticket prices and limit total air travel, and use the funds to streamline the development of biofuel infrastructure. If these steps are taken soon, there may be hope of achieving carbon-neutral flight by 2050.

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