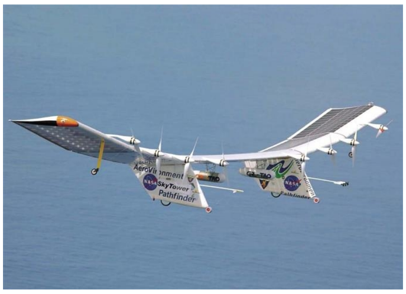
Goodbye Fuel World

Air travel is responsible for 700 million tonnes – around three per cent – of global carbon emissions every year. But if the growth of aviation continues, this could rise to three billion tonnes by 2050. Now, despite being perceived as resistant to environmental change, aircraft manufacturers and airlines have come together in an unprecedented act of co-operation in the search to survive in a world after kerosene.

Fast forward to the year 2040. Your flight from London to Singapore has many trappings familiar from the days of fossil-fuelled aviation, such as long queues at check-in and interminable delays at the gate. But other elements are quite different. Having reached the end of their working lives, the antiquated generation of Airbus 380 Superjumbos and Boeing 787 Dreamliners are being replaced by twin-fuselage aircraft, intensely aerodynamic and flown on a fuel derived from algae.

The stuff of science fiction? Perhaps not. Two problems have prodded the aviation industry into a search for new fuels: increasing global demand for oil from all industry sectors, accompanied by a steep rise in oil prices; and the requirement and expectation that the aviation industry plays its part in reducing its environmental impact.



According to the International Air Transport Association (IATA), today's global fleet is 65 per cent more fuel-efficient than it was in 1970. And the clean technology of modern aircraft engines has almost eliminated emissions of carbon monoxide and hydrocarbons. This, however, clearly isn't going to be enough, and the IATA wants a carbon-free aircraft flying by 2050.

Dropping in

There are good reasons why kerosene has fuelled aviation's extraordinary expansion: it has a high energy content, an extremely low freezing point at altitude and proven reliability. Furthermore, the world's major airlines have invested heavily in leasing new aircraft with a working life of at least 30 years, so aviation has effectively locked itself into the kerosene-propelled design for the foreseeable future.

This means that the alternative to kerosene will have to be a 'drop-in' fuel, one that meets the precise technical and operational specifications with which jet engines have been designed to work, and could simply replace kerosene in the supply, storage and transportation chain of existing jet aircraft. The industry's primary focus is on second-generation biofuels from sources such as algae or jatropha.

In February 2008, a Virgin Atlantic 747 flew from London to Amsterdam using fuel derived from Brazilian babassu nuts and coconuts. The same month, Airbus flew one of its new A380s with one engine powered by an alternative fuel known as gas to liquid (GTL). The test involved the conversion of synthesized natural gas to liquid using what's known as the Fischer-Tropsch process. GTL has similar greenhouse gas emissions to kerosene, but fewer particulates, which may have some mitigating effects on contrails and on air quality at airports on the ground. Rolls-Royce and British Airways, meanwhile, are evaluating alternative-fuels tenders from more than 30 companies for a series of tests to be conducted next year.

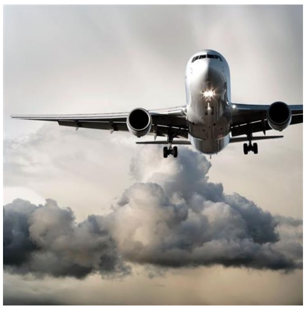
Some airlines are understood to envisage GTL as an alternative fuel, although Airbus discounts this. Instead, it argues that the success of its test flight established the principle of using alternative fuels in a system designed for kerosene-propelled jet engines. Rather than GTL, Airbus expects this to be biomass to liquid (BTL) fuel.

'We've demonstrated that GTL works, so when we find a second-generation biofuel feedstock that can be produced in industrialised quantities, then we can use the Fischer-Tropsch process,' says Justin Dubon, a spokesman for Airbus. 'The fuel that comes out is indistinguishable from jet fuel, other than that it comes from sustainable and clean sources. Finding the right fuel that scales up is the big challenge.'

Airbus aims to have identified this source by 2015, and it reckons that by 2025, a quarter of all jet fuel could be from non-processed oil sources. It estimates that by 2030, up to 30 per cent of all aviation fuel could be sourced from second-generation biofuels.

The need for the fuel to scale up is vital. If first-generation biofuels were used, then one calculation has concluded that, in order to supply the needs of all Europe's airlines, the whole of Europe would have to be planted with the crop. Other, more energy-intensive potential solutions offer more hope. A senior expert at a major airline says that if algae were used as a BTL fuel, 'you would only need to cover Belgium to meet the same needs'.

It appears unlikely that one single fuel source will replace kerosene, but that a range of fuelstocks will be converted to liquids of compatible standards - less a silver bullet, according to Richard Altman, executive director of the Commercial Aviation Alternative Fuels Initiative, and more a 'silver buckshot' solution. 'Some fuels could only be grown in certain parts of the world,' says Altman, who envisages a scenario where an aircraft would land in New Delhi, refuel on jatropha-based BTL, then fly to New York where it might refuel on algae-based BTL. 'The need would be to have all such fuels compatible and sufficiently generic to accommodate different sources in different locations.'



Designs for the Future

The move for more environmentally friendly flights has also turned to air traffic control. According to the

IATA, the redesign of air routes and improvements in air traffic management could reduce fuel burn by between eight and 18 per cent.

Other proposals appear to inhabit the deeper recesses of the 'Dan Dare' imagination. Among the more eye-catching concepts suggested is a twin-fuselage aircraft designed by scientists at Russia's Central Aerohydrodynamic Institute and submitted to the EU-funded New Aircraft Concepts Research (NACRE) group. While the scientists outline what they describe as promising results, they admit that the design 'may lack passenger appeal'.

Such startling prototype designs abound, and generally aim to improve airplane efficiency through a major change in the airframe configuration. According to Ilan Kroo, professor of aeronautics and astronautics at California's Stanford University, these include planes with a blended-wing body (BWB) design, where the thick centrebody accommodates passengers and cargo without the extra weight of a fuselage. Versions of the BWB have been designed to accommodate 250-800 passengers.

NACRE is also looking at ways to overcome ever-stricter demands to reduce noise pollution, and such steps could also help cut emissions. Current research is focusing on open-rotor engines, which involve an exposed turbine rather than the conventional huge fan and would, for safety reasons, probably require the engine to be located in the middle of the aircraft. Rolls-Royce reckons that open-rotor engines will be available in the second half of the next decade, and tests by Boeing and others have found that they reduce fuel burn by anything from ten to 30 per cent. The Silent Aircraft Initiative, a UK-government-sponsored joint venture between the University of Cambridge and the Massachusetts Institute of Technology (MIT) is taking aircraft design further into the realm of noiseless flight. The Cambridge-MIT team is exploring ways for the entire plane to create lift, not just the wings. The prototype SAX-40 aircraft, which would carry 215 passengers, has engines located where you would expect the tailfin to be, and would burn fuel at a rate of 53 passenger kilometres per litre of fuel, compared with about 42 for the best current aircraft in this range and size. This is equivalent to a Toyota Prius hybrid car carrying two passengers.

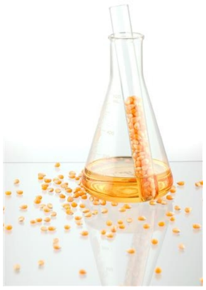
The design would also produce noise of around 63dBA outside the airport perimeter - about 25dB quieter than current aircraft. Other areas being explored by the team include putting the engines above the aircraft, so that the body of the plane itself shields the ground from noise; embedding them in long ducts, muffled with acoustic liners; and relocating the engines inside the airframe.

The Light Fantastic

The concept of the airship as a means of mass transport, which apparently went down in flames with the Hindenburg in 1937, is also enjoying a revival - although in a significantly revised form - and research and development work on launching a new era of lighter-than-air transportation is surprisingly active. In the USA, the Defense Advanced Research Project Agency (part of the US Department of Defense) is actively developing prototype airship drones for surveillance and freight transport; in the UK, Hybrid Air Vehicles (HAV), a Bedfordshire-based company, says it can deliver its first Skycat hybrid air vehicle within 36 hours of a confirmed order.

The hybrid air vehicle differs from the traditional airship not only in appearance but also in structure, with a hovercraft-style base enabling it to take off and land vertically or from short airstrips. The craft also has greater maneuverability than a conventional airship, as it banks to corner. Flying at around 100 knots (185 kilometres per hour) and at an altitude of 3,000-4,000 feet (900-1,200 metres), its fuel consumption - typically of kerosene, although biofuels or GTL could also be used - works out at around half that of a typical 737.

But those looking to fly commercially in such a craft shouldn't hold their breath. 'There are a lot of dreamers in this industry, and while passenger flight is something we have in mind, they won't be the first orders,' says Ken Nippress, chief scientist for HAV. Instead, the company anticipates creating a niche market for freight transportation; for example, carrying cars made in China to the central USA in two or three days, replicating sea freight cargoes.



Carbon Targets

For now, however, it's all about kerosene. The airlines, despite their protestations that aviation's contribution to climate change is modest, know that they have to clean up their act, for reasons of self-preservation as well as the environment.

British Airways aims to halve its carbon emissions by 2050 and reduce the ratio of carbon per passenger-kilometre travelled from 111 grams today to 83 grams by 2025, partly with the aid of emissions-trading schemes. 'We clearly understand that flying is a polluting activity and we need to minimise it,' says Jonathon Counsell, head of environment for BA. 'Carbon involves a cost and airlines should pay for the damage we inflict on the environment. Our right to exist as a business depends on our ability to reduce our impact on the environment.'

Inaction, according to Altman, isn't an option. 'Everybody's going to have to worry about fuel supplies,' he says. 'If aviation simply relies on fossil fuels, then there will be limitations to growth. There's a perception that aviation could be the industry that uses the last drop of fuel. But does it want to have that against its name?'

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