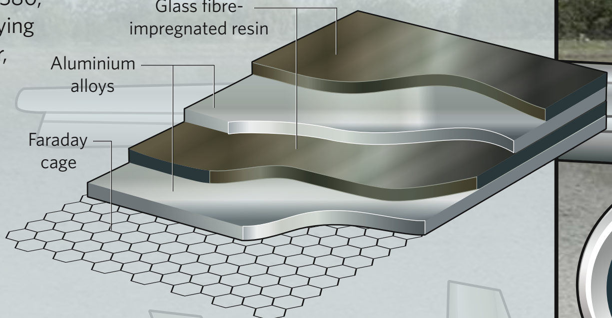
Flights of green fancy

Air travel shows no sign of losing its allure but its environmental impact is not going to go away. **Katharine Sanderson** looks at some of the ways that scientists and engineers hope to reduce the carbon wing-print of aircraft.

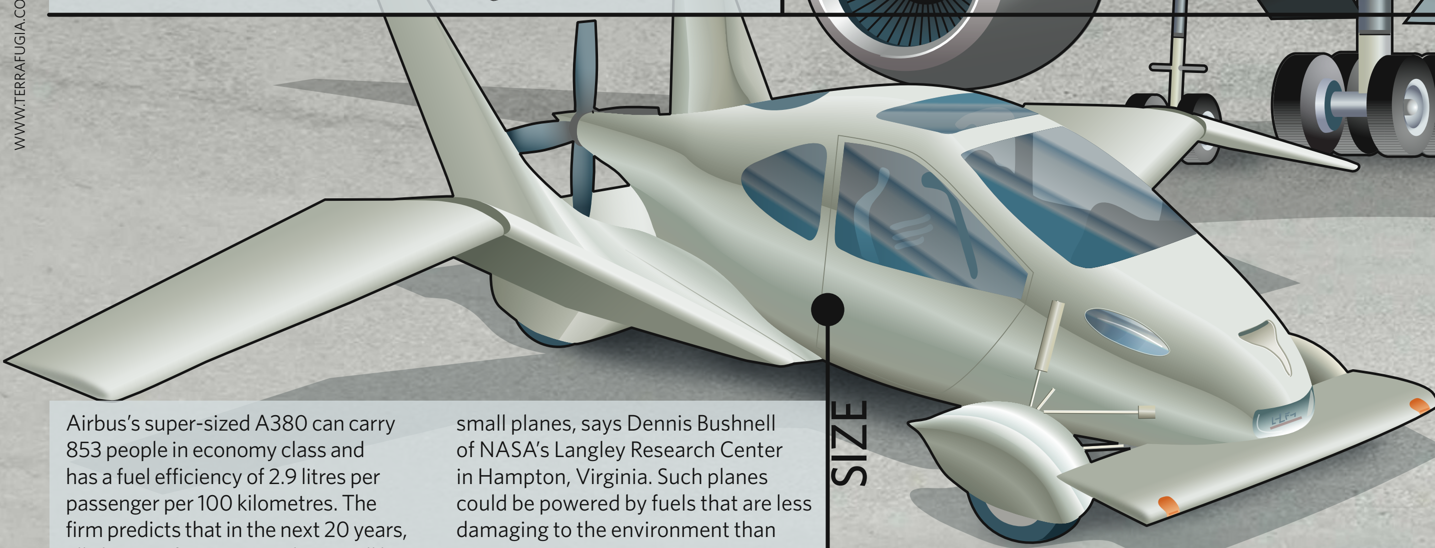
MATERIALS

Replacing all the metal in aircraft with lightweight composite materials could reduce fuel consumption by 25%, says aeronautical engineer Ian Poll of Cranfield University, UK. The fuselage of Boeing's 787 Dreamliner plane, to be unveiled in 2009, is made entirely of plastic reinforced with carbon fibre. Half of the aircraft's weight will come from composite materials. Airbus's megaplane, the A380, which has been flying since last October, has a composite material in sections of its upper fuselage. The material, called GLARE, is made from alternating thin layers of aluminium and resin impregnated with fibreglass, making it more rigid and impact-resistant. GLARE could be combined with large sheets of conducting carbon nanotubes to protect against lightning. The nanotubes would be a lightweight replacement for the metal that lines the fuselage, and would form what's known as a Faraday cage.



LOGISTICS

Streamlining air traffic globally could improve fuel efficiency by 12%, saving 73 million tonnes of carbon dioxide emissions a year, according to the Intergovernmental Panel on Climate Change. Geneva's International Air Transport Association claims that cutting flight times by 1 minute could save up to 4.8 million tonnes of CO_2 (and $4 billion at current prices) a year.



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SIZE

Airbus's super-sized A380 can carry 853 people in economy class and has a fuel efficiency of 2.9 litres per passenger per 100 kilometres. The firm predicts that in the next 20 years, all classes of passenger planes will be 25% bigger than they are today. "We believe that one of the solutions to try to reduce the environmental impact of aviation is to have fewer flights," says Airbus spokesman Justin Dubon.

Conversely, global satellite positioning systems could lead to personal, autonomous airflight on small planes, says Dennis Bushnell of NASA's Langley Research Center in Hampton, Virginia. Such planes could be powered by fuels that are less damaging to the environment than current sources.

The concept of a flying car remains popular, with many prototypes. Terrafugia, based in Woburn, Massachusetts, has a model called Transition, which has wings that fold out for flying and retract for driving (sketched above). Its car-plane should be available in 2009 for US$148,000.

FUELS

Algae look like the most likely candidate source for an aviation biofuel that won't compete with food for land. Algal biofuel can be made by cultivating high-fat-content algae to produce a biodiesel for use in a blend as jet fuel (see scheme). Other companies are looking at algal fermentation processes, hoping to make an aviation fuel directly.

In February, Airbus made a test flight with a synthetic liquid fuel made from natural gas. Such strategies pave the way to incorporating biomass-to-liquid fuels in the future, once they can be produced routinely from algae or other feedstocks such as jatropha or prairie grass.

Ross Walker, engineering programme manager for alternative fuel projects at Airbus, predicts that commercial flights will be powered by 25% biofuel by 2025. Whether 100% biofuel will be used is less certain "but it's an aspirational goal for the industry", says Boeing's Terrance Scott. UK entrepreneur Neil Laughton plans to fly his biofuelled, parasailing flying-car (pictured left) from London to Timbuktu, Mali, next year.

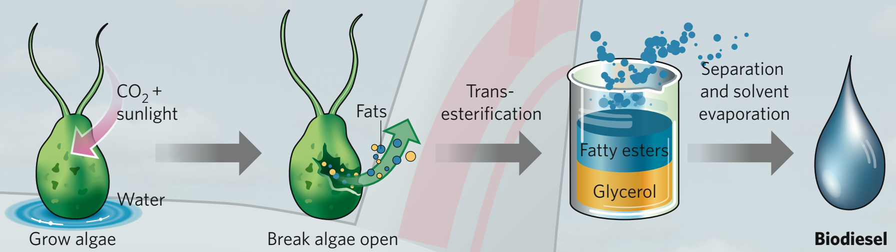
Nuclear power would remove the need for a gas turbine. The idea was first touted in the 1940s, and experiments were done by both the US and Russian governments during the cold war. Nuclear planes are dismissed by some as too risky in case of crashes.

In December, APAME, an association promoting electrical aircraft based in St Pierre d'Argençon, France, flew Electra, the first conventional plane to fly on battery power alone, using lithium polymer batteries. Christian Vandamme, Electra's pilot, predicts that a battery-powered four-seater plane will be available in the next 10 years, and beyond that the development of a small commuter plane to carry up to 20 passengers.

A plane powered by hydrogen — the European Union and Airbus Cryoplane project, launched in 2000 — never came to fruition because technologies to provide enough hydrogen for fuel are not yet available.

Boeing is testing fuel-cell technology using a small demonstrator aircraft, which is some 15–20 years away from public use. A fully solar-powered manned aircraft, *Solar Impulse*, plans to fly through the night, and round the world, in 2009 (see *Nature* **451,** 884–886; 2008).

Others are investigating the possibility of using airships to transport freight around the globe.



WINGS

The biggest chance to make aerodynamic improvements, and so save fuel, will come from new wing shapes. Blended wing body designs (see image below) are being developed to replace the tube-and-wing design now in use. A tubular fuselage is parasitic — it adds to the drag on the vehicle, but doesn't provide lift. Blended wing bodies remove the need for a fuselage: passengers can sit within the wing, as long as they don't mind not being able to see outside. The shape means that lift is generated over almost the entire structure. Drag is also reduced because the wetting area — the amount of the plane's surface in contact with the air — is reduced in a blended wing body compared with a conventional tube-and-wing design, so there is less friction between the wing and the air. The 'Silent' Aircraft Initiative by the University of Cambridge, UK, and the Massachusetts Institute of Technology in Cambridge, uses a blended wing shape to try to reduce noise to almost zero by improving aerodynamics and shielding the engines from the ground, which also saves fuel.

R. FERGUSON/BOEING/NASA

ENGINES

In today's engines, the turbine is a similar size to the engine fan, and they both spin at the same speed. But turbines are most efficient when spinning quickly, and engine fans are most efficient when going much slower. Introducing a series of gears allows the turbine to spin much faster than the engine fan, which can in turn be bigger without demanding much more power from the turbine. A bigger fan ensures that most of the thrust comes from air that avoids the inner fuel-burning part of the engine — improving performance and reducing fuel burn. Engine manufacturer Pratt & Whitney in Connecticut is developing a geared turbo-fan that promises initial fuel savings of 15% and additional savings of 1% per year after the engines come into service. The engines have been snapped up by Japanese company Mitsubishi to use on the Mitsubishi Regional Jet, and Canadian aerospace company Bombardier will be using the engines on its CSeries. Both are due to enter service in 2013.

Another alternative is to use open-rotor, or unducted, fans with rotor blades that are free from any casing, removing a lot of drag from the system. But these fans would need to be large, potentially cancelling any fuel efficiencies by needing heavier propeller blades. They would also be very noisy.