

Flying into the future

# How technology is changing the passenger cabin for whatever class you fly

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THE twinkling stars above the passengers gradually fade away as the night sky lightens and the sun begins to rise. It is an illusion, as it has long been daylight outside. But the projected image has a purpose: gently to awaken those on board and help their body clocks adjust to a new time zone. As the airliner begins its descent to New York, the ceiling and walls turn transparent to provide a panoramic view of the Manhattan skyline. And on lining up to a runway, the aircraft's seats automatically change shape, becoming more upright and firm to provide additional support for the landing. Welcome to JFK airport, sometime in 2050.

This vision of what it will be like inside an airliner of the future comes from Airbus. The European aerospace giant got its engineers to look at how flying might evolve from the passengers' perspective. The fuselage has a "bionic" structure constructed from composite materials which mimic the bones of those masters of flight: birds. The composition of bone consists of fibres, which are light but also immensely strong when arranged to carry tension where it is needed. The structure saves space and also helps to reduce the aircraft's weight, so it burns less fuel.

The upper part of the bionic cabin is covered with what Airbus describes as a "biopolymer membrane", a sort of tough plastic coating which can be electronically controlled to turn opaque or transparent on command, thus eliminating the need for conventional windows. This too helps to make the fuselage light and strong.

The traditional rigid divisions into first, business and economy classes have gone. This is thanks to the transforming seats. Made from "memory" materials which can morph into a different shape and then return to their initial form, they adapt to the size of an individual's body—and their travel budget. The more you pay, the more space and comfort the seat will provide. This would enable airlines to configure seating according to demand. And that means there will no longer be any need to upgrade passengers from cattle class if the rear is overbooked.

The technological elements that could make this concept become reality can already be seen in new aircraft and in cabin designs that are much closer to production. How the experience of flying will change depends, however, as much on the unforgiving economics of air travel as on the imagination of the designers.

Producing the interior of an aircraft is a costly business—not least because in order to provide a distinctive product most airlines want something different, so the insides are custom-built. As a result carriers will spend some \$10 billion this year, up by 5% from 2014, on cabin interiors for new and refurbished aircraft, estimates ICF International, a consultancy based in Virginia. Making that kind of expenditure pay depends on what flyers you have in mind.

In the battle for passengers, the price of the ticket is usually the most important thing. Given a choice, air travellers always say they want more room and extra comfort, but are usually not prepared to pay any more money for them—or at least not a lot more. The emergence of various forms of a new airline class, often called “premium economy”, is an answer. But there is a widening gulf between the luxury of first and business classes, and the austerity endured by hoi polloi at the back.

The differences are most apparent in the amount of space a passenger gets. The seat pitch in standard economy (measured as a point on one seat to the same point on the seat in front) is typically between 78cm (31 inches) and 82cm. Spirit Airlines, a budget American carrier, has trimmed the pitch of its standard-economy seats to just 71cm. At the other end of the spectrum Abu Dhabi’s Etihad Airways is offering a nearly 12-square-metre three-room first-class suite with a shower called “The Residence” on its Airbus A380s. It comes complete with a private chef and a butler trained at the Savoy Hotel in London.

### Turn left...

It is in the business-class cabin that airlines are spending most heavily, however, because it is more profitable for them. One seat manufacturer reckons that this year airlines will install in new and refurbished aircraft roughly 2,000 new seats in first class, but 50 times as many in business.

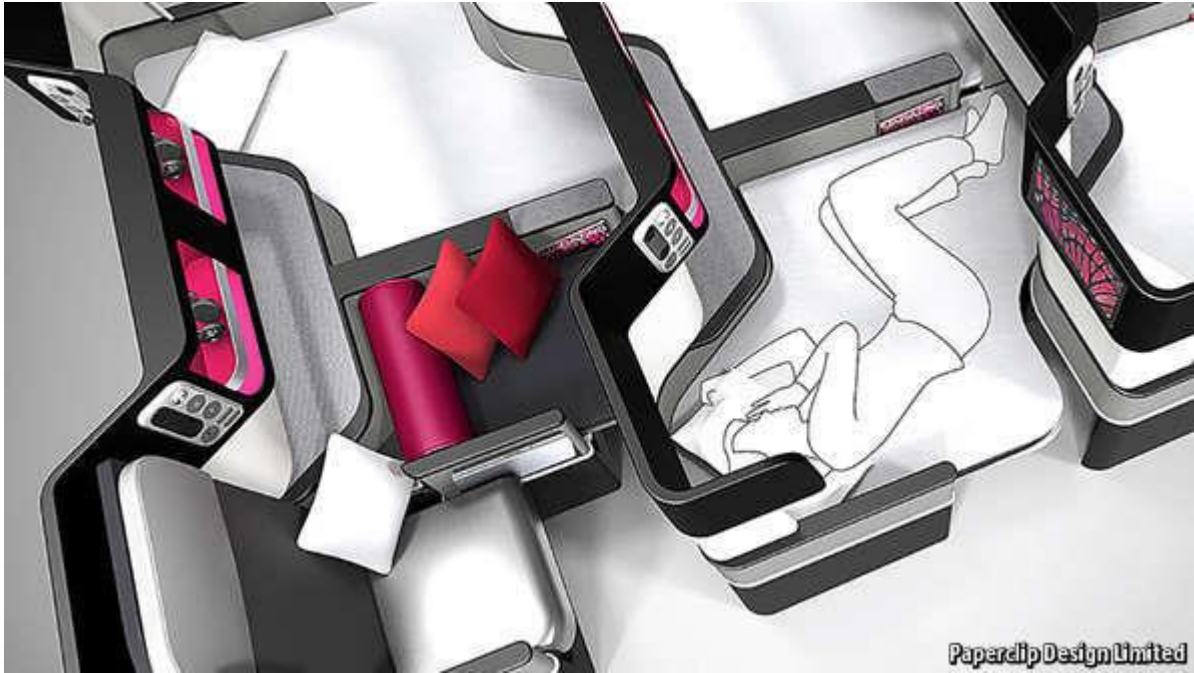
Business class has already changed a lot in recent years. It can provide the same or a better level of comfort than that available in the first-class cabin less than a decade ago. For a start, if a business-class seat does not extend into a fully flat bed, the airline’s offering is no longer “even in the game”, says Blake Emery of Boeing, America’s biggest aircraft manufacturer.

The result is that business seats are turning into areas of personal accommodation. These spaces will get more sophisticated and specialised. Teague, a Seattle company which has designed interiors for all models of Boeing’s airliners, worked with Nike, sleep experts and professional coaches to design a concept called the “athlete’s plane”. It includes a training room and a sleeper pod (pictured) to enhance relaxation. The effects of air travel on the body’s natural rhythms means that athletes travelling over multiple time zones are statistically more likely to lose against a home team, says Teague’s Devin Liddell.



Teague’s bed for weary athletes

Powerful computer-aided design and simulation provide designers with more ways to explore the clever engineering required to create as much room as possible in a confined space. Paperclip Design, a Hong Kong company, has come up with the closest thing yet to a morphing seat. Called Butterfly (also pictured), it is composed of units of double seats with the aisle seat offset backwards. In premium economy both seats would be used, but the cabin could be upgraded quickly to business by having the inboard seat left empty to flip over as a sleeping platform.



Paperclip Design's transformer seats

Another approach involves positioning seats at various heights to gain space. Jacob-Innovations, a Massachusetts firm, has a design called StepSeat that lifts every other seat about 18cm allowing extra room for them to recline. A more radical arrangement is a series of stacked cocoons called Air Lair (illustrated). It offers a third more passenger capacity, says Adam White, head of Factorydesign, its London creator. So far, airlines have tended to shun these so-called 3D-seating set-ups because they think that some passengers, for reasons of status, will not want to sit on different levels.



Airborne pod life

Developing and designing a new business-class sleeper-seat or pod can take two years or more, and top-of-the-line models might cost up to \$350,000 each, once they are stuffed with electronics. The price is partly explained by the standard required to protect passengers from a seat breaking in a crash. This was raised in 2009 by America's Federal Aviation Administration from withstanding a deceleration of nine times the force of gravity (9g) to 16g. Although this means that seats and their fittings have to be made stronger, the use of lightweight composite materials, such as carbon fibre, allows thinner seats to meet what has now become a global standard.

Carbon fibre is already widely used to make aircraft fuselages and wings. It is stronger than steel but lighter even than aluminium. That strength comes from the powerful links between carbon atoms—similar to the toughness imparted to a diamond. The fibres are woven together and arranged in position using detailed computerised stress-analysis for maximum strength. The fibres are then embedded in a

hard resin. Carbon technology is advancing rapidly, with even greater performance characteristics claimed for single-atom-thick layers of graphene. Such work may well lead to the advanced composites needed to make bionic fuselage structures.

### ... turn right

New lightweight technologies are also having an impact in the back of the aircraft. Last year Air Méditerranée, a French carrier, removed the 220 economy seats in an Airbus A321—it bought them for about \$300,000 in 2006—and replaced them with a new, lighter version. The skinny seat (pictured) is made by a Paris startup called Expliseat and weighs just 4.2kg (9.3lb) compared with the 12kg seat it replaced, says Air Méditerranée's Christophe Costes.



Expliseat's seat-frame is constructed of titanium and carbon fibre. The "titanium seat", as it is named, cost Air Méditerranée nearly three times as much as each aluminium one it replaced, but this will be more than compensated for by fuel savings. Expliseat's lightest seat weighs just 3.9kg. Air Tahiti, which has also bought the company's seats, reckons the weight savings will allow some of its turboprop aircraft operating off short runways to carry 55 rather than 50 passengers, says Benjamin Saada, Expliseat's co-founder.

That hints at how the space savings from thinner seats are likely to be used in economy: not to provide more legroom but instead to pack in an extra row or two of seats. Some new aircraft will also have smaller lavatory cubicles as a result of more petite plumbing. All this helps seating "efficiency", the industry's euphemism for density. Shrinking the seatback pocket and placing tray stowage higher on its seats has already helped Germany's Lufthansa increase seating on its Airbus A320 fleet from 150 to 168, says Samuel Engel of ICF International. Tallying the additional seats packed into all aircraft in its fleet, Lufthansa gained the equivalent capacity of 12 new A320s, he adds.

It could be worse. Some carriers have flirted with standing room. Spring Air, a Chinese budget carrier, has proposed installing such a scheme to increase capacity on its aircraft by 40%. In 2012 Michael O'Leary, never one to miss making headlines, promoted the idea of a padded backrest for standing passengers on Ryanair, the Irish discount carrier which he runs. Aviointeriors, an Italian seatmaker, produced a downward-sloped perch called Sky rider but got no takers. Public reaction, says Ermanno De Vecchi, the firm's boss, was, in essence, "sitting on a saddle crammed in like a sardine? Forget it." Safety certification for "standing" seats would, in any event, be highly improbable.

If more space in the economy cabin is unlikely, passengers on all budgets will see some benefits from the changes to cabins. First, technologies that reduce weight and therefore fuel consumption should help to lower fares further. Even the padding in the seat cushions is changing with improved materials. New types of foam and fire-resistant coverings have been developed to produce lighter cushioning. This has resulted in a fall in the weight of a typical seat's cushioning from 1.8kg a decade ago to less than half a kilo now, according to Aviointeriors. Mark Hiller, head of the aircraft-seating division of Recaro, a German firm, says that in 20 years the company has cut the overall weight of its seats by 20% on three separate occasions. Each kilo of weight shed from an aircraft reduces its annual fuel bill by at least \$100, he adds.

Second, new designs may help address some of the most common irritations of economy-class travel. Having a passenger drop his seat backwards into another passenger's space is a great cause of angst. (Hence the brisk sales of a \$22 gizmo called the Knee Defender, now banned by some airlines, which attaches to a tray strut and prevents the seat in front from reclining.) James Lee, the boss of Hong Kong's Paperclip Design, has come up with a fixed-position seat in which the back cushion can be lifted forward from the bottom and kept inclined by stuffing a briefcase or jacket behind it. This "anti-technology" seat, adds Mr Lee, has the benefit of doing away with a reclining mechanism. Expliseat's titanium seat also remains upright.

## Elbows at war

Another annoyance is the battle over a shared armrest. But Mr Lee has an answer for that, too. He has patented a design with two flat surfaces at different heights, providing room for two elbows (pictured). Having knees pushed into passengers' backs is a further frustration. Expliseat embeds a taut sheet of a secret polymer into the rear cushion to absorb the shocks of impacting knees. The material is lighter and softer on the kneecaps than the rigid plastic shields which are sometimes used, adds Mr Saada. Teague's Mr Liddell says one area where more innovation is needed is to make the dreaded middle seat more inviting—especially in economy. At the moment, he adds, for passengers the middle seat is “your sentence for waiting too long to book”.



Two can be company sharing an armrest and seats that are slimming down

The third improvement is likely to be the ambience of the cabin. BAE Systems, a British firm, recently made its first sale of a set-up called IntelliCabin that features LED lighting designed to induce calm, improve sleep and charm flyers with illumination schemes like an artificial sunset for dinner, says Jared Shoemaker, head of cabin technology. A Boeing team of engineers, psychologists and marketing people are also concocting LED-lighting schemes to make cabins appear roomier—“to essentially distract people from the discomfort” of a tight squeeze, says Boeing’s Mr Emery. Accentuating ceiling curves with sky-blue light generates a “sense of space expanding above” and bathing vertical surfaces in white light creates an illusion of greater width.

When Boeing’s 787 was introduced in 2011 it pioneered a number of enhancements. The aircraft is fitted with large “electrochromic” windows that trap a thin gel between two panes of glass. An electrical current is applied to darken the gel, allowing passengers to choose from five transparency settings. The 787 also improves the air in the cabin. Airlines have long kept air dry because humidity corrodes metals. But that is less of a problem with the 787’s largely carbon-fibre fuselage. This means the air can be more moist. And because carbon fibre is stronger than aluminium, cabin pressure can be maintained at a higher level, closer to what it is on the ground. The 787 also pumps air into the cabin electrically rather than having it bled from the compressors in the jet engines, which risks fumes entering.

## The goggle box

Augmented reality might help ease the journey, too. Epson, a Japanese electronics firm, has created goggles, called Moverio BT-200, which project images onto a lens that appears to be a screen five metres away. Some of the first versions are being tested by a South Korean airline. The goggles could be used to watch films, which in the future are likely to be beamed wirelessly around the aircraft’s cabin, eliminating the need for lots of bulky in-flight entertainment equipment.

Video screens made from thin films could be used on the back of skinny seats and placed on cabin walls to provide an enhanced view of the outside and, eventually, as a replacement for windows. The view would be relayed to the screen by exterior cameras.

The Centre for Process Innovation, a British technology group, is exploring the use of organic light-emitting diodes (OLEDs) to make the thin-film screens. OLEDs use a luminescent layer of organic compounds to emit light in response to an electric current. Matthew Herbert, a manager at the centre, says that in less than a decade production technology will be inexpensive enough to mass-manufacture flexible OLED displays for use in aircraft. Using such screens instead of windows would reduce weight and improve the strength of the fuselage. One company, Spike Aerospace of Boston, is proposing to replace windows with screens in a supersonic executive jet (see [article](#)). Step by step, the vision of that New York-bound flight in 2050 is moving closer to reality.