Who's flying this thing? End in sight for pilots

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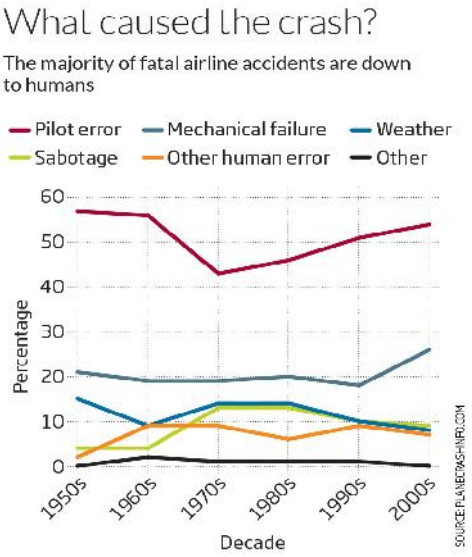
Computer pilots could make human error a thing of the past. But would you get on a plane flown by a machine instead of a captain?

1 JUNE 2009: Air France flight 447 is cruising from Rio de Janeiro to Paris when it hits a tropical storm in the mid-Atlantic. Minutes later, the Airbus A330 flies into the ocean, killing all 228 people on board.

On a sunny July morning four years later, an Asiana Airlines flight approaching San Francisco airport smashes into the sea wall just ahead of the runway, severing the entire tail section and sending the fractured fuselage cartwheeling across the airstrip. Three people died and dozens were injured.

These incidents appear unrelated, yet they share a tragic similarity: the pilot of each plane believed his flight control systems would automatically prevent the aircraft from stalling or flying too slowly to stay airborne. They were wrong.



It turns out that this type of mix-up is a major contributor to a number of air crashes. And the confusion is set to get worse. With more things becoming automated, pilots can get muddled when something goes seriously wrong, losing track of where the autopilot's responsibility ends and theirs begins. It is a recipe for disaster

So is it time to lose the human pilot altogether? Certainly many in the industry think so. Far better, they argue, for airliners to fly autonomously, under the remote supervision of pilots in an office thousands of kilometres away. Safety-wise it seems to make sense – flight crew error has been implicated in about half of all fatal airline accidents (see graph).

Along with improved safety, pilotless passenger planes could offer dramatic cost savings for airlines and passengers alike. Without pilots, airlines would spend far less on salaries, simulator training, healthcare, layover hotels and retirement benefits, says Mary Cummings, a researcher in autonomous flight at Duke University in Durham, North Carolina. That should translate into lower fares, and automated flight should also be more fuel efficient, helping to further reduce costs and cut greenhouse gas emissions. And with the pointy end of the aircraft no longer taken up by crew, spectacular, panoramic views would be on offer to passengers in the front seats – provided they pay a little extra, of course. There's just one key question: how would you feel boarding a plane without a human hand at the helm?

At the heart of this revolution lies a simple fact: computers now do so much on planes that airline pilots rarely have cause to take the controls. Autoflight computers can take over when the plane is just 30 metres off the ground, maintaining whatever speed, heading and height the crew tap into the flight management system. And the computer has long been able to home in on a runway radio beacon and land the aircraft automatically.

Yet automation introduces fresh challenges for pilots. When autoflight computers experience situations they haven't been programmed to handle – sudden structural damage to the aircraft, say, or extreme weather like that experienced by flight 447 – they can unexpectedly throw responsibility back to the pilots. Those pilots may become confused over the level of control they have been handed when something goes seriously wrong. Equally dangerous is the fact that flight deck

computers can overload pilots with a blizzard of alerts, checklists and audible alarms at critical moments. In November 2010, for instance, an engine exploded on Qantas flight 32 with 469 people on board, cutting 650 control wires. Yet as pilot Richard de Crespigny tried to land at Singapore, he and his co-pilot were distracted by 120 menus of instructions flashing on their screens.

The US Federal Aviation Administration recognises that humans and computers may not be the safest combination. In 2013, it published results of a seven-year study revealing a litany of dangers posed by the pairing of humans with flight deck automation. The FAA's chief investigator, Kathy Abbott, found that pilots habitually "rely too much" on autoflight systems and are "reluctant to intervene, even when they suspect the systems are not performing as they should". Pilots continue to be confused over the state of the autoflight system, the report warns.

In the short term, airlines are trying to reduce these risks by redesigning computer systems and giving pilots extra training. In the longer term, using less automation in the cockpit might even seem a sensible solution. Yet many in the aviation industry are pursuing another path: reducing the role of fallible humans in the cockpit even further.

A consortium of plane-makers, including Boeing, Airbus, BAE Systems and Dassault, has started a €30 million, four-year research project to provide computer assistance for pilots during emergencies. Called the Advanced Cockpit for Reduction of Stress and Workload project (ACROSS), its aim is to use computers to help reduce the dangerous peaks in workload that can lead to confusion during a crisis. The idea is for automation to allow a pilot or co-pilot to cope alone should the other be incapacitated. Yet ACROSS is going further than that. One objective is to identify the key challenges needed to create an autoflight system that replaces the co-pilot entirely – allowing single-pilot operation from take off.

However, even if an ultra-smart machine intelligence works fine as a co-pilot, what would happen if the lone human pilot became incapacitated? According to Cummings, any computerised co-pilot good enough to work with a lone human must be able to assume complete control – to take off, fly and land the plane entirely on its own – should the pilot fall ill. So why bother with the human? It would certainly reduce the risk of confusion.

Humans redundant?

Bolstering this reasoning is a 2013 study by a team at NASA's Ames Research Center in California. It found that an autoflight system for a new generation of single-pilot very light jets still led to high workloads that tax a pilot "to the point that errors in navigation and flight control occur".

"All aviation researchers recognise that moving from two pilots to one is an intermediate step that will allow us to go from one pilot to zero," says Cummings.

Indeed, Cummings believes that the era of fully automated planes is inevitable. In her former job as a US navy pilot, she realised her fighter jet's autoflight system made her all but redundant. It could land the craft on the deck of an aircraft carrier far better than a human, she says. "It adjusted direction, airspeed and altitude much faster than I could."

Computers have the edge in split-second operations because eye-to-brain communication is slower than sensor-to-processor transmission. "From the time you see a stimulus that requires action, to the time you act on it, is at best half a second," she says. A computer, meanwhile, takes just milliseconds to detect sensor signals and act on them. "Humans cannot keep up."

Experience with US military drones confirms this – their crash rate dropped markedly the more automated they became. In particular, improvements were achieved by preventing pilots flying take off and landings, when crashes frequently happened. "Take off and landing are close to the highest workloads pilots experience," says Cummings: almost half of all fatal airline incidents occur during these stages of flight.

So how far away are pilotless passenger planes? Well, one already exists, after a fashion. An unpiloted Jetstream airliner operated by BAE Systems has been flying 800-kilometre trips to see how it interacts with other aircraft and air traffic controllers – although it still has a crew on board, just in case.

The Jetstream contains arguably the beginnings of the machine intelligence that pilotless planes will need – a smart flight management systemMovie Camera called the Airspace Integration Processor (AIP). The AIP avoids collisions using radio, radar and camera-based sensors, and communicates with a ground pilot via satellite. After being given destination coordinates, the AIP can plan waypoints for a route, taking into account hazardous weather and air traffic restrictions, says BAE flight engineer Rod Buchanan.

Despite these advances, it is unlikely that passenger airlines will be the first to introduce pilotless planes. Cummings expects cargo carriers such as FedEx and UPS to be the first plane operators to drop from two pilots to just one. This will allow the technology to be tested in the same aircraft as those used by airlines, but with no passengers aboard. If that proves safe, we can expect to see cargo airlines ditching the crew completely by around 2035, she suggests. Instead, a pilot based at a company's hub would watch over a fleet of cargo planes via satellite, ready to assume control if anything goes wrong.

But flight automation technology could come into its own much earlier. Thanks to rapid developments in electric propulsion and intelligent flight controls, the time of flying cars or "personal air vehicles" (PAVs) may finally be near, and the key to commercial success will be complete automation, researchers believe. After all, learning to fly costs thousands of pounds, and if large numbers of us are to safely fly our PAVs in a crowded sky, we'll need a computer at the helm. "You cannot have the current volumes of road traffic in the air and still have manual flight control," says Mike Jump, an engineer at the University of Liverpool, UK, and part of the MyCopter project which is building the automation software for a vertical take off PAV. He predicts lift-off for flying cars by 2025.

There is no doubt that automation will be attractive to airline operators: after fuel, crew are one of the industry's major costs. Senior pilots can earn $240,000 or more a year and require regular training and refresher courses, in addition to benefits such as healthcare and pensions. The time they can spend in the air is also tightly regulated. "Flight crews have physical needs and strict duty periods, and those limit flight time," says aviation consultant Donough Wilson from Coventry University, UK.

Automation means better fuel economy too, says Cummings – an autoflight system won't stray off the optimum route and so need to use extra fuel getting back on track. What's good for an airline's bottom line, and the environment, could also benefit passengers by helping to keep seat prices down. And if pilotless planes can help reduce turnaround times between flights, they might go a little way towards reducing delays. Plane-makers could even rethink layouts. "Without the need to house pilots up front, there is no need to conform to current aircraft designs," says Wilson. Losing the flight deck could offer passengers the views usually only enjoyed by pilots.

Of course, the big concern with full automation is what happens if the systems fail and there is no on-board crew to take control. For example, it is unlikely that an AI "pilot" could ever match the bizarre-but-brilliant decision to ditch on the Hudson River, as Chesley Sullenberger did in January 2009, so preventing fatalities when his plane's engines failed over New York City. Perhaps not, says Bryant Walker Smith, a lawyer who researches risk and technology at the University of South Carolina in Columbia, but airlines might be prepared to accept the risk of such freak accidents. "If automation eventually succeeds in reducing the number and severity of crashes and injuries, then even if manufacturers are liable in a greater share of crashes, their actual [risk] exposure might not be higher," he says.

But pilots are unlikely to let themselves be replaced by techology without a fight. "We will only be able to build resilient pilotless aircraft when we can replicate human consciousness, awareness and prediction in a machine," says de Crespigny. "Until then it is pilots who have the only chance of saving people."

Richard Toomer, spokesman for the British Airline Pilots Association agrees: "Passengers want to know they are in the hands of two well-trained, well-rested pilots. We can't see that changing anytime soon."

Yet with driverless cars expected on the roads soon, people may become more comfortable with the idea of fully automated vehicles – Cummings says she has seen some evidence of this in a recent survey. But she admits that many will be reluctant to accept pilotless planes. "Moving from two pilots to one will be easier than from one to zero," she says: it's a technological challenge that will face regulatory and cultural resistance too.

The roots of that cultural resistance run deep, says Robert Bor, a clinical psychologist at the Royal Free Hospital in London, who specialises in aviation psychology. "It comes down to a primitive fear of not being in control." Passengers like to see a capable person in charge of a plane – someone who has as much to lose as they do if things go wrong. And although pilots acknowledge that they are often simply monitoring automated systems, Bor argues that passengers still see them as "calm-under-stress, uniformed people who wrestle with the controls and battle against the odds on our behalf". Cummings agrees. "The need to see a James T. Kirk on the bridge is strong," she says.

It will be up to the aviation industry to demonstrate equal or better safety levels than crewed planes, says Bor. So would he fly in a plane flown by machine? "I'd need clear evidence from extensive experiments showing it is safe," he says. "But if I was told tomorrow I only have a ground pilot, I'd be troubled. I think it is going to be a hard sell."