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Would aviation underwriters suffer fewer losses if aircraft did not have pilots?

by Suzanne Bazire

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Introduction

In this document I will be looking principally at scheduled commercial operations

I currently work as a Chartered insurance broker for general aviation, a class which encompasses all aircraft operations other than those capable of carrying in excess of 60 passengers per flight. In general aviation (GA), pilot hours are looked at in depth by brokers and underwriters as many of these operations are hand-flown with a lack of automation, so pilot experience is highly relevant to the risk profile.

I am also a fully trained commercial pilot. My most recent flying role saw me conducting single-pilot instrument flight rules (SPIFR) operations in the UK, being totally reliant on my own decision making and training. I made mistakes but lived to learn from them; others have not been so lucky.

Pilots are highly trained but they are ordinary people; they may be tired, busy, stressed or they may have family and financial concerns. However, their failure to pay sufficient attention or be properly prepared for their day job can lead to catastrophic consequences. Would aircraft be safer and therefore, aviation a more profitable class of business, if human pilots were removed from the equation?

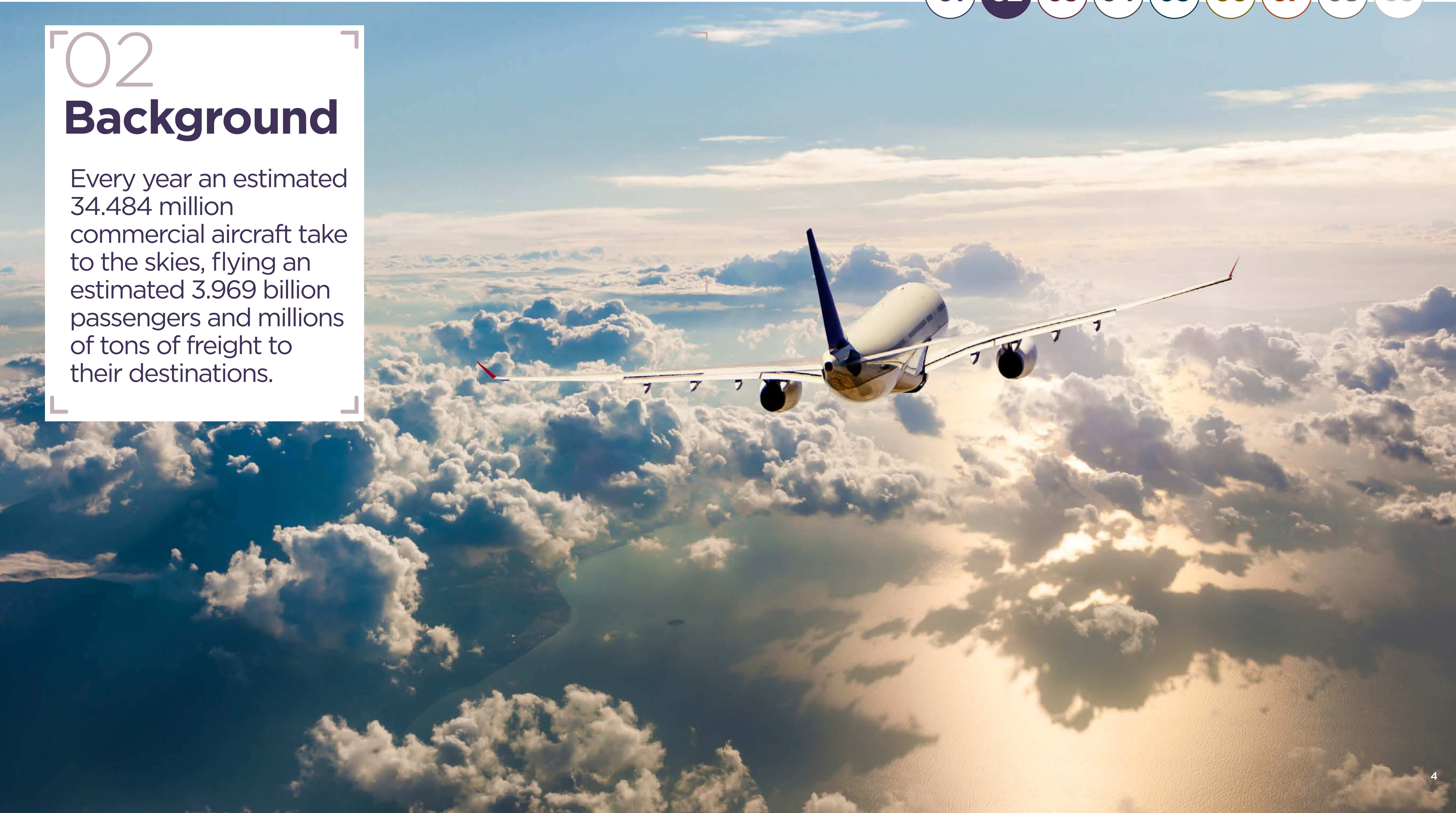
In this document I will be looking principally at scheduled commercial operations, therefore general aviation figures where private pilots fly for fun are not considered. Whilst many of these pilots rely on technology such as Global Positioning Systems (GPS) or basic heading and height hold whilst in cloud to complement their skills, the very act of flying the aircraft "hands-on" is what provides the pleasure of this pursuit, so automation is unnecessary making it irrelevant for this discussion.

Suzanne Bazire

02

Background

Every year an estimated 34.484 million commercial aircraft take to the skies, flying an estimated 3.969 billion passengers and millions of tons of freight to their destinations.



Background

Despite an increase in scheduled departures, the International Civil Aviation Organization (ICAO) 2017 safety report shows a decrease in the number of accidents in member states, with 2017 the "safest year ever for commercial aviation" according to Flight Safety Foundation[1].

Aviation is an ever-changing environment often affected by factors outside of its own control; terrorism, weather events or market forces can all exert significant and unpredictable influence which the industry must withstand, often with no warning.

"9/11" was an atrocity which the world could never have predicted or prepared for. The aftermath of the event led to a 5.9% decline in US passenger traffic in one year and a revenue loss of USD 19.6 billion to US airlines alone, with the industry not returning to profit until 2005. Well-known airlines such as Delta, United and Northwest were forced to file for Chapter 11 bankruptcy[2].

In 2003, the identification and spread of Severe Acute Respiratory Syndrome (SARS), a respiratory condition causing flu-like symptoms[3] in the Americas, Europe and Asia led to a 3% annual decline in scheduled flights worldwide[4]. Whilst the 2010 eruption of the Eyjafjallajökull volcano in Iceland emitted an ash cloud closing vast swathes of European and Atlantic airspace causing the greatest aviation disruption since September 11 2001; it resulted in lost revenues of USD 400 million per day at its height[5].

The aviation industry weathered these unforeseen challenges and subsequently experienced sustained growth with the International Air Transport Association (IATA) predicting 7.2 billion passengers being carried in 2035, almost double the numbers travelling in 2016[6]. However, this growth comes with its own challenges.

In early 2016 in the US, Republic Airways who operate flights for Delta and American Eagle filed for bankruptcy. The reason was not due to lack of demand, it was, amongst other things, exactly the opposite: "grounding aircraft due to a lack of pilot resources". The reasoning has also been attributed to the failure of Seaport Airlines and the reduction of capacity at SkyWest[7]. These figures are supported by the 2017 Boeing Pilot & Technician Outlook report which predicts that 637,000 new commercial airline pilots will be required in the next 20 years due to increased demand and current pilot retirement[8].

Why are airlines struggling to recruit personnel to this highly attractive job?
The reasons are numerous. Firstly, a commercial airline pilot today does not have the same privileged life as even 20 years ago. Long gone are the extended stopovers in exotic locations for long haul crew with many pilots now having to return the following day. Short haul pilots are rostered to fly a multitude of sectors on one day with consecutive days of 5am starts, increased time pressures if they face delays down route and resultant time zone fatigue.

In the past, many commercial pilots came from the military which had borne the cost of their flight training providing the airlines with well qualified, disciplined personnel requiring minimal re-education. However now, due to defence cuts, there are fewer military pilots and these pilots fly less hours than before, meaning most entrants come from training schools where the applicants have self-funded their course. Airline crew pay is still very competitive with experienced captains earning up to £140,000 per year[9]. With full ATPL studies requiring an investment of around £60,000, and no guarantee of a position upon qualification, the entrant pool is extremely limited. One in six European pilots are now self-employed, with an increasing trend in low cost carriers zero-hour contracts with pilots being placed on standby and only being paid when they are called to fly[10].

Flight crew are expensive; they require pensions, national insurance contributions, sick days and holidays. While they may make mistakes, what if they were not required? With airlines typically employing 10 pilots per aircraft to cover rostering and rest requirements, UBS believes that airlines would save USD 35 billion by using pilotless aircraft, but is this just a theoretical situation?[11]

Aviation is an ever-changing environment often affected by factors outside of its own control.

03

Argument against pilots

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Argument against pilots

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The accident report highlights factors often found in aviation accidents, this being a chain of events leading ultimately to disaster. Both aircraft were routing to Las Palmas in the Canary Islands when a bomb closed the airport, causing both aircraft to be diverted to Tenerife. On departure, the airport taxiways were congested due to the additional aircraft and exacerbated by low cloud and mist, leading to some aircraft being invisible to each other and the tower. Whereas aircraft would usually use a taxiway adjacent to the runway, KLM 747 was instructed to back-track (taxi down the runway against the direction of take-off, performing a 180-degree turn at the end to wait for take-off instructions) with Pan Am 747 following it down with instructions to vacate onto a taxi way further up.

Once the KLM aircraft had completed its 180-degree turn, the pilots requested take off clearance and were advised of the route they must follow out of the airspace. The captain acknowledged this, confirmed that they would be taking off and began to increase engine thrust, but crucially missed the instruction to hold their position a few seconds later. Seconds after they began their take-off role, the Pan Am crew reported that their 747 was still on the runway, placing them directly in the path of the departing KLM aircraft. All communication between aircraft under the same air traffic controller is audible to all aircraft and therefore this was heard in the KLM cockpit. The flight engineer on board the KLM queried this immediately and was barely acknowledged by the captain who continued the take-off role, leading to impact between the aircraft 13 seconds later and the death of 583 people.

Many of the contributory factors are understandable. Air traffic control (ATC) was overloaded, the KLM crew were subject to weather challenges, they were behind schedule and worried about going over their allowable duty times which would lead to further delays. Whilst the investigation led to worldwide changes in aviation language with "take-off" now being used only once clearance has been given by ATC, many of the contributory factors were human as seen when the KLM captain overruled the co-pilot who advised that they did not have clearance and began to open the throttles regardless. He then further ignored the flight engineer who correctly identified that the Pan Am 747 had not vacated the runway.

The Federal Aviation Administration (FAA) report concluded that contributory factors include a "fixation on what was being seen (increased fog)", a degree of relaxation after executing a challenging 180 turn and the influence of the KLM captain's "great prestige making it difficult to imagine an error of this magnitude on the part of an expert pilot".[12]

The perceived inability of a co-pilot or junior member of staff to raise concerns is a factor highlighted in the study of aviation human factors. Whilst western flight schools specifically train the importance of co-operation in the cockpit with targeted courses, pilots in other countries where cultural power differential is revered, may not feel able to raise concerns. This may have been a contributory factor in the death of four people and the destruction of a Korean Air 747 in the UK in 1999 when the experienced captain over-banked the aircraft and consequentially impacted the ground whist the co-pilot remained silent[13].

Language barriers have also been identified as contributory factors such as in relation to the Avianca Flight 52 accident when an aircraft that was low on fuel was placed into the hold at JFK Airport and did not declare an "emergency". The lack of clarification from the crew regarding their rapidly worsening situation meant that ATC did not prioritise the landing of the aircraft which ran out of fuel after executing a missed approach leading to the deaths of 73 people[14]. The reliance on non-standard language was also a contributory factor in the collision of a CJ2 and MD-87 in Milan in October 2001 leading to the deaths of 116 people[15].

Many of the worst (non-terrorism) aircraft accidents can be directly attributable, either wholly or partly, to: human error; pilots disobeying ATC level orders (as seen in the "Charkhi Dadri" mid-air collision in 1996 with

Argument against pilots

349 deaths or the delay of a Saudi Arabian Airlines pilot in evacuating his aircraft following an onboard fire meaning all on board perished from smoke inhalation in 1980); incorrect control input or incorrect buttons pressed (American Airlines 2001 and China Airlines 1994); and incorrect checking of data and liaison between staff (Air New Zealand 1979)[16].

Pilots are humans and experience the same limitations as all of us; they may be tired, they have domestic pressures and they wish to succeed in the job for which they trained long and hard for. The British Airline Pilots Association (BALPA) has recently voiced concerns regarding the rosters imposed on pilots which are leaving them suffering "burnout"[17] and Flight Safety Foundation has issued a report investigating why only 3% of unstable approaches result in the official "go-around" procedure being followed[18]. Are the pilots unsure of the procedures, pressurised for time or maybe embarrassed to admit that they could not finalise the approach and had to have another attempt?

In a study conducted by UBS, it was found that 70-80% of aviation accidents are attributable to human error with fatigue attributable for 15-20% of these[19]. Humans are also subject to failings which would never occur on a pilotless aircraft: they may accidently knock a transponder leading to a lack of location data provided to ATC and the subsequent impact on collision avoidance, as suggested as a possible cause of the Embraer Legacy 600 and Gol Airlines accident in Brazil in 2006[20]. They may also experience hypoxia, a condition where a lack of oxygen in the body decreases cognitive ability leading to confusion and reduction of mental faculties. This was experienced in the case of the Helios Airways 737-300 incident when the correct cabin pressurisation was inadvertently not set, leading to the crew becoming incapacitated and the aircraft subsequently crashing into terrain after running out of fuel. Having experienced deliberately induced hypoxia during flight training, I can attest to its insidious nature[21].

Most recently, we have the case of pilot suicide on Germanwings Flight 9525 in 2015 leading to the deaths of all 150 persons on board due to a lack of reporting of the pilot's deteriorating mental health[22].

All of the above may lead us to conclude that a fully automated, computer-controlled aircraft without expensive, fallible human pilots may be a safer way to proceed in the future.

Pilots are humans and experience the same limitations as all of us.

04

Argument for pilots

However, there are times that computers fail.

Argument for pilots

On 19 July 1989, 1 hour and 7 minutes into a flight from Denver to Chicago, a United DC-10, suffered an undetected fatigue crack in the No 2 (tail-mounted) engine leading to the engine's destruction and the failure of three hydraulics systems which led to the aircraft entering a descending right turn.

The hydraulic failure caused a severely degraded response from the flight controls with the pilots mainly controlling the aircraft's movements by increasing or reducing thrust on the remaining two engines. Although this flight ultimately ended with fatalities, it took the combined knowledge and skill of three flight crew with over 10,000 hours on type between them just to line the aircraft up at the diversion airport of Sioux City[23]. Would a computer have been able to replicate 10,000 hours of experience and have the flexibility to control the aircraft dynamics with engine thrust rather than the usual control inputs?

In October 2008, Qantas Flight 72, an A330 was cruising at 37,000ft after leaving Singapore for Perth, Australia when an inconsistent reading on the angle of attack sensors led the aircraft to believe that it was approaching a stall (where there is insufficient airflow over the wings to keep the aircraft flying). The controlling computer provided a set of incorrect warnings and then compensated for the perceived stall by sharply pitching nose down which, despite lasting only two seconds, led to 110 passenger and 9 crew injuries. The pilot overrode the autopilot, corrected the pitch by pulling the aircraft out of the dive and landed safely after diverting[24].

Furthermore, in 2010, Qantas Flight 32, an A380 from Singapore to Sydney suffered an uncontained engine failure four minutes after take-off after oil released from a faulty pipe ignited in the engine causing damage to wing surfaces, hydraulic and electrical systems; this was the first incident experienced on the new Airbus A380 aircraft. Five pilots were in the cockpit that day, two of which were highly qualified check pilots. The engine explosion led to constant warnings that were dealt with by all of the crew for a total of 50 minutes whilst in a holding pattern. The aircraft landed successfully, however No 1 engine was shown as shut down in the cockpit despite still running and was subsequently flooded by fire teams to stop it[25]. Would a computer have been able to deal with such an overload of warnings? Maybe. But it would not have been able to liaise with ground crews regarding the still-active engine whist arranging passenger embarkation as this was only possible by telephone and one radio due to the electrical system's emergency power mode setting.

No discussion on pilot ability can be made without mention of the bird strike on US Airways Flight 1549 on 15 January 2009 when Captain Chesley "Sully" Sullenberger safely landed a fully laden A320 on the Hudson River, saving all persons on board. The captain, having over 19,000 hours total flying time including 4,765 hours on A320s, made the considered opinion that he could not safely return to any airport and that the Hudson River would be the safest option to ditch the aircraft and evacuate the passengers[26]. His decision proved correct; it was subsequently proven in regulated tests that a return to La Guardia, the departure airport or an attempt to divert to other nearby airports may not have been achievable. Would a computer have been able to assess this situation and select water as a safe landing area?

Despite all the technology at our fingertips and the amount that we trust our daily lives to it, the question remains, would customers fly on an aircraft that does not have a pilot in the cockpit? Time has shown that automation is becoming more acceptable to us with London's Docklands Light Railway or monorails found in cities and theme parks being unequivocally accepted. But is there a psychological barrier with flying?

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05 Technological development

There is no doubt that technological ability has exponentially increased in the previous decades.

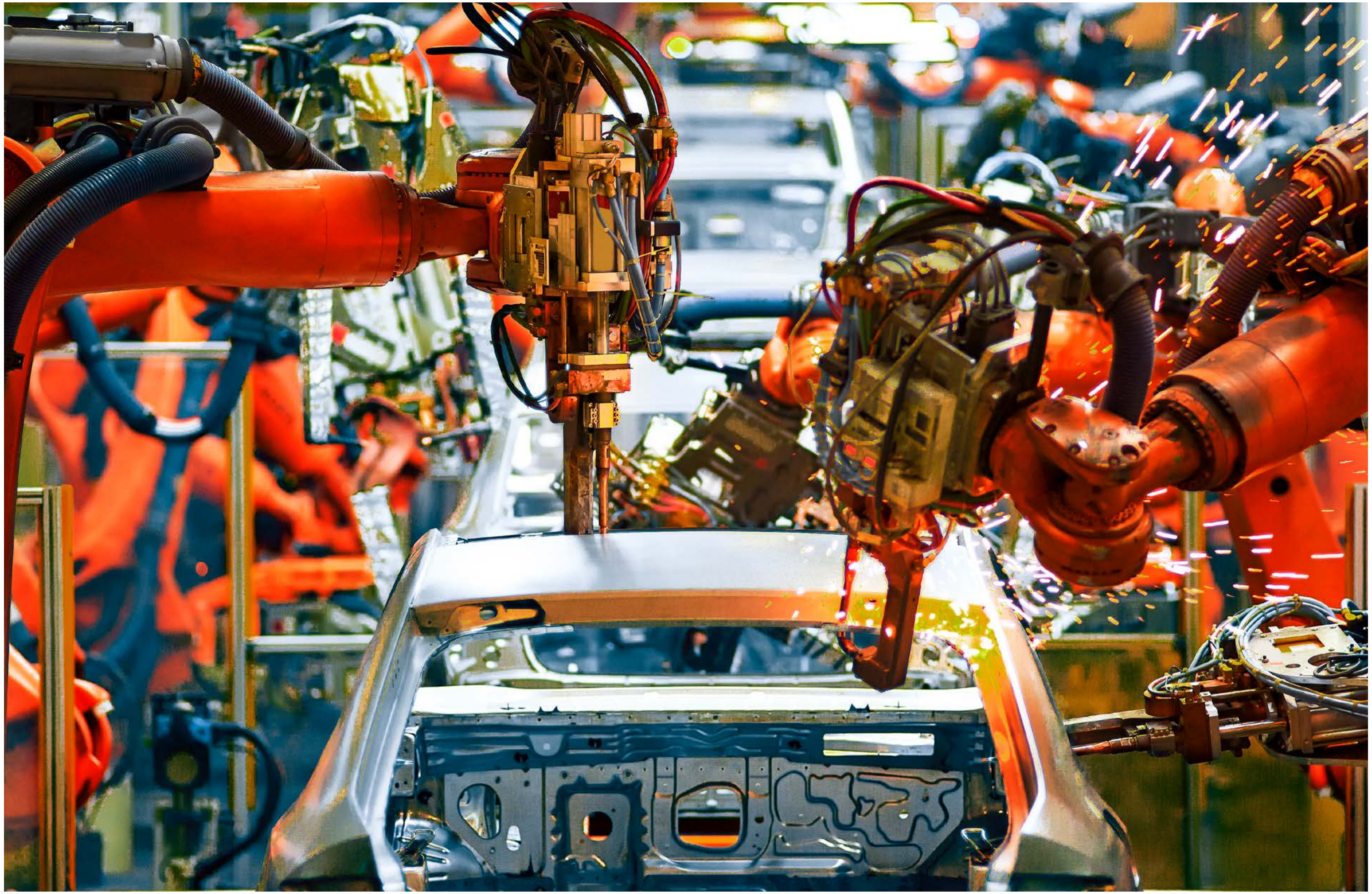
Courtesy of Amazon Air

Technological development

There is no doubt that technological ability has exponentially increased in the previous decades. The iPhone, the internet and GPS were all incomprehensible to the public less than 20 years ago, but we would find it hard to live life without them now.

This digital age is heralded as the "Fourth Industrial Revolution" by the World Economic Forum[27]: an age driven by new technology including artificial intelligence (AI) and digitisation.

Large companies are already aware of the benefits of automotive technology for safety and possible cost-saving reasons; the manufacturing industry has already replaced humans with robotics and automation in many factories. In respect of transport, in the marine industry, Rolls Royce are estimating remotely operated local vessels by 2020 with fully autonomous unmanned ocean-going ships being in place by 2035[28]. With road vehicles, Jaguar Land Rover have been testing automated vehicles in Coventry and Milton Keynes, with many other large brands such as BMW, Mercedes-Benz and Google testing prototype autonomous vehicles with the UK Government's November 2017 Budget stating that "fully driverless cars" will be on our roads by 2021[29].



In October 2017, Boeing announced plans to buy Aurora Flight Sciences Corporation, a company specialising in "autonomous systems technologies to enable advanced robotic aircraft" and mentioned the use of "robotic co-pilots"[30]. Also that month, Israel Aerospace Industries unveiled its Air Hopper, an unmanned helicopter that can be used to evacuate wounded personnel from battlefields and take logistics to the front line, removing the need for human exposure to this risk[31].

Drones are technology of which most people are aware, if not already an owner. In the US alone, Gartners anticipate the global drone revenue to be USD 6 billion by the end of 2017 increasing to USD 11.2 billion in 2020. It is estimated that 2.8 million of these drones were to be purchased for commercial use in the 2016-17 period[32].

Whilst drones are being extensively integrated into military operations, many are used in the oil and gas industry for turbine or pipeline inspections where it is easier and safer to send a drone than put security protocols in place for human operatives. They are now also being used by emergency services as seen in January 2018 when Australian lifeguards use a drone to drop life-saving equipment to persons in distress 700 meters offshore in the space of a few minutes[33].

Much has been made of agricultural applications for drones. Crop spraying is a class of business known for its high loss ratios; pilots often fly at 500ft for extended periods of time requiring constant concentration and the avoidance of objects whilst releasing chemicals onto crops that would otherwise be damaged by large industrial machines or applied slowly by hand. Precision agriculture technology has been used for crop dusting in Japan for the last 25 years with Yahama's RMAX helicopters alone treating 2.4 million acres of farmland in 2014 providing both speed and safety benefits[34]. In this area, pilots are already becoming superfluous.

Furthermore, Airbus have developed the Zephyr, a High Altitude Pseudo-Satellite (HAPS) which is solar powered and aimed at providing military and commercial uses. The technology used here is interesting as the Zephyr operates out of the line of sight requiring that "the aircraft be fully autonomous in its navigation, flight control and power management".

With Amazon currently testing its Prime Air delivery system where small packages are delivered to customers within 30 minutes by drone[35] and Uber investigating the use of automated air taxis using vertical take-off and landing technology[36], these developments all appear to be natural precursors to the creation and acceptance of a computer-controlled aircraft.

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06
Challenges of technology

Autopilot, which assists in following complicated procedures and maintaining aircraft spacing, has been used by commercial airliners for decades although the FAA forbids its use below 500 feet on take-off, unless given specific dispensation.

Challenges of technology

However, this extensive use of autopilot has led to a concern regarding the pilot's ability to take control when an unexpected event occurs.

A study by Flight Safety Foundation in 2010 was conducted on 30 experienced commercial pilots, of which 80% reported that below 10,000ft they would manually fly the aircraft. When faced with a simulation of which instruments would be available if automation failed, the pilots' overall performance fell below the required FAA standard[37]. This over-reliance on technology has led to a reduction of basic piloting skills.

Whilst there are no reported incidents involving automated ship trials, on 7 May 2016, a Tesla S car being tested in autopilot mode, collided with a tractor trailer at a road intersection in Florida leading to the death of the Tesla occupant. Early investigations pointed to faults in the automatic braking system, however the US Department of Transportation closed their investigation after no defect trend was found[38]. The problems caused by drones approaching commercial airliners have already been well publicised.

Artificial intelligence uses computers to simulate human intelligence. The computer analyses large amounts of data picking out patterns which it learns to interpret over time enabling it to apply the outcome to new situations[39]. Unlike a human, it does not forget, get distracted or bored. The initial beliefs are that the co-pilot's position would be replaced by a computer to assist the captain in identifying errors and patterns. However, even this step requires extensive rework to the aircraft cockpit as in current designs, one pilot cannot see all displays or reach all buttons. Nevertheless, the crew of aircraft have already been reduced with advances in technology leading to the lack of requirement for a flight engineer as warnings now show on aircraft panels and can be corrected by a computer.

For commercial airliners, the adoption of technology may be hindered by the costs of infrastructure that would need implementing at airports. With some developing nations still using basic radio navigation aids to guide pilots, advanced technology of this kind is decades away.

Development within the airline industry itself is also very slow. In November 2017, the Chinese state-owned company Comac announced that their narrow-bodied twin jet airliner C919 undertook its first intercity test flight successfully. The concept aircraft was first announced in 2008 with the first unveiling in November 2015 following unspecified delays and first test flight in May 2017[40].

In December 2017, Rolls Royce and Airbus announced plans to collaborate and build a new electric engine with the intention to demonstrate this technology on an aircraft by replacing a jet engine with an electric engine by 2020[41]. That same month, Japan Airlines announced that it had invested USD 10 million in Boom Supersonic, a company backed by Sir Richard Branson which is aiming to re-engineer a supersonic jet by 2025[42].

As can be seen from the timelines in the above examples, development is not fast in the aviation industry; aircraft are created years in advance and must undertake numerous tests to satisfy regulators that the aircraft are safe to operate. Therefore, the reality of a fully automated passenger-carrying airliner being normality is still some way in the future.

We must also consider the logistics of this change. For example, if EASA, the European Aviation Safety Agency, approved purely automated aircraft, but the Federal Aviation Administration of the United States did not, a fully automated aircraft could not fly between these two continents and would have to remain inside EU airspace. It would then be further restricted to those airports that had the required infrastructure to interact with the aircraft. Even if the technology was approved worldwide, the cost of installation would be tremendous with installation phased in by countries when they had the ability to do so.

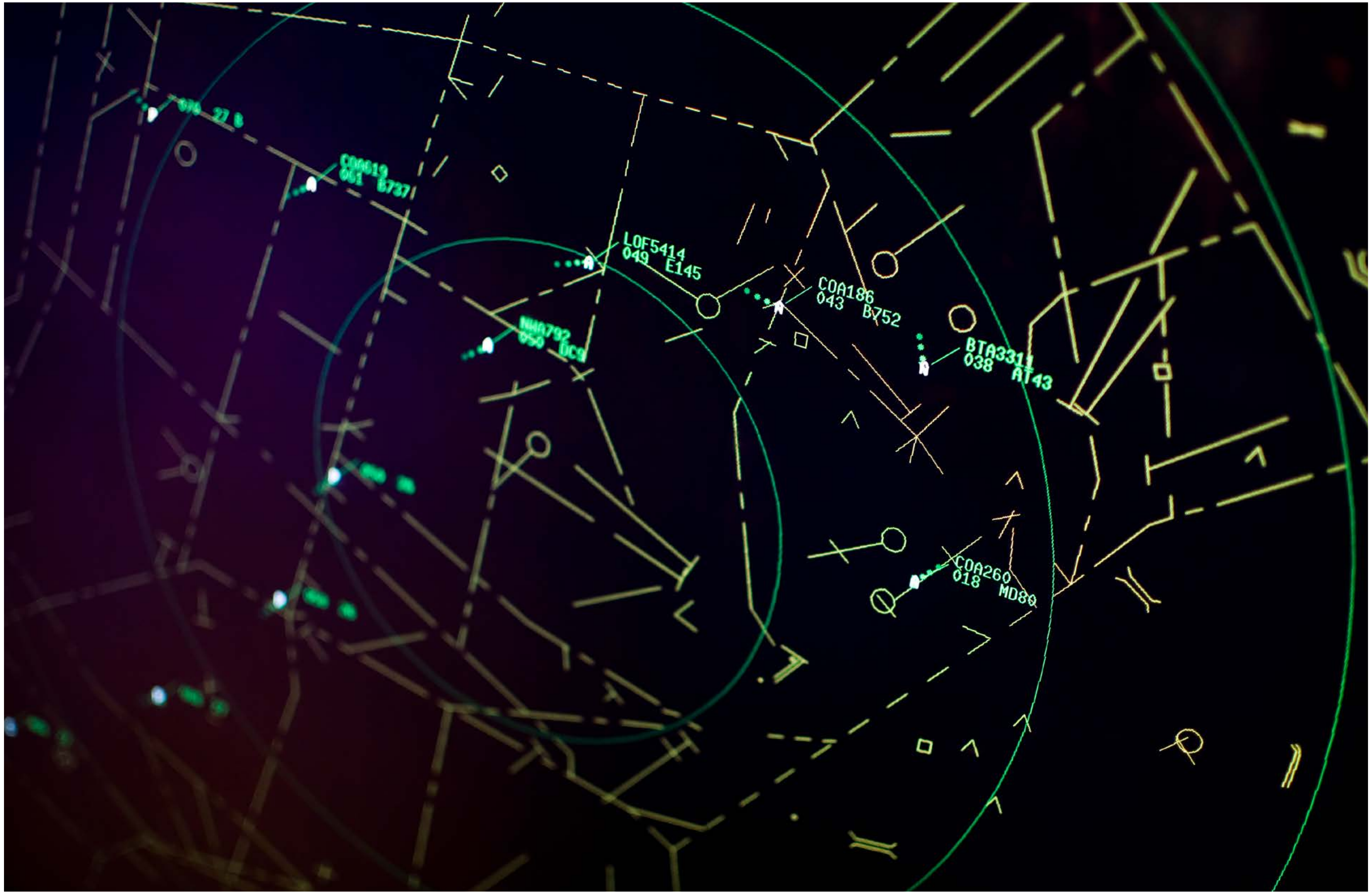
However, in the world of air taxiing for short journeys, the usage of autonomous drone-type aircraft between set areas such as office roof tops is already under review for development as seen in the September 2017 trial of Dubai's Autonomous Air Taxi (AAT)[43].

Artificial intelligence uses computers to simulate human intelligence. Unlike a human, it does not forget, get distracted or bored.

Challenges of technology

The perils of cyber risk is a topic about which those of us in insurance are used to hearing, but how could this impact commercial aviation? Cyber risks come in a multitude of forms, it may be that IT systems fail; however there is increasing usage of cyber crimes to permeate terrorism or create denial of service attacks for ransom. Today all flight planning is electronic, pilots use “electronic flight bags” which contain all required data for en route activities and the FAA is upgrading its ATC systems to “NextGen” with GPS software connected to the internet[44]. The exponential usage of internet-connected applications creates more entry points for hackers, all of which require state of the art protection.

Hacking may be carried out for the challenge, for political reasons such as in the case of malware infecting Boryspil Airport in Ukraine (allegedly planted by Russia) or it may be used for financial ransom such as the WannaCry ransomware affecting over 150 countries in May 2017. It has been suggested that some states such as North Korea may extend their use of hacking for ransom as a way of increasing income as sanctions hit the country’s economy[45]. By the very nature of technological innovation and by the time a new product is launched, the technology it uses to support itself will be outdated (Moore’s Law tells us that processing power doubles every two years[46]) and is therefore more vulnerable to attack. The ability of a nation state to enter the systems of a commercial airliner or national ATC centre and take control of an aircraft for ransom or terror is frighteningly conceivable.



07

Prohibitors of pilotless aircraft

A recent study by consultants Plant Wellness Way demonstrated that even in a well-managed company with normal quality control, the best human error rate is 5 in 100 opportunities with the average being between 10 to 30 errors per 100 opportunities[47].

Prohibitors of pilotless aircraft

If we remove human crew, the aircraft must still be controlled by some means. The aircraft would contain specially designed cockpit technology which is linked via satellite to a controlling system which in turn would be linked to governmental ATC and local airport systems.

However, by removing pilots, are we merely transferring their costs and liabilities to those of software engineers?

The cost of crew has previously been discussed but the new systems for automated aircraft require construction and maintenance. Aircraft that fly more require more maintenance with components and engines having limited life spans before overhaul.

The product liability implications are also a substantial consideration; who is at fault if the aircraft control system fails? Would airlines be able to subrogate against aircraft manufacturers for faults? If so, this would require new product liability cover requirements. The aviation insurance world is agile and willing to accept new risks, but pilotless aircraft would still pose a challenge with no previous data on which to base premium rating.

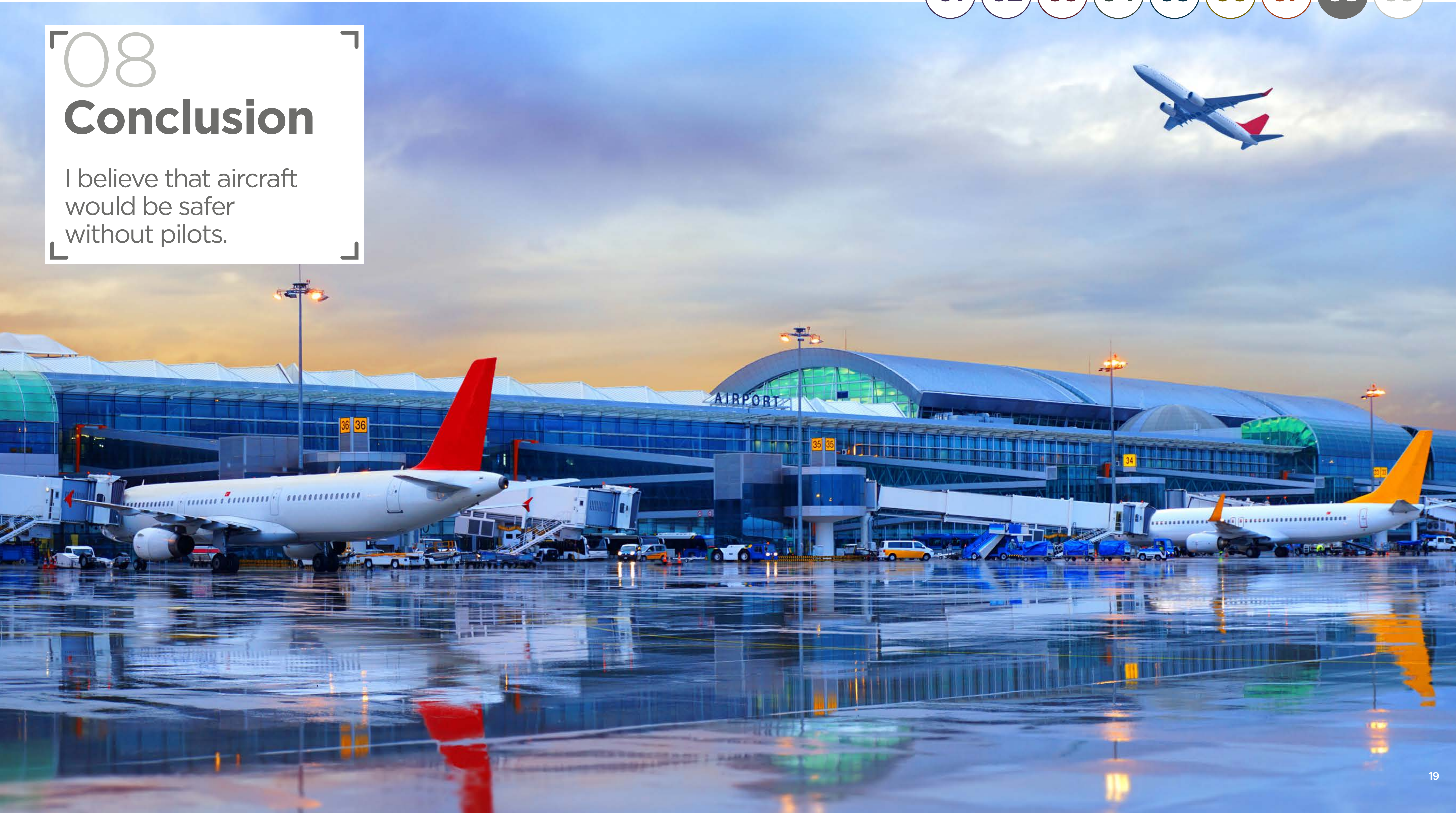
Are the increased costs of cockpit design and technological infrastructure for full automation prohibitively expensive?
Would airlines and aircraft manufacturers ever be able to recoup this investment cost from seat/cargo sales and an improved safety record? With only 17% of people in a 2017 study by UBS willing to fly on a pilotless aircraft[48], airlines need to consider if this would be commercially beneficial.

However, by removing pilots, are we merely transferring their costs and liabilities to those of software engineers?

08

Conclusion

I believe that aircraft would be safer without pilots.



Conclusion

I believe that aircraft would be safer without pilots. Despite the intense training and constant assessments ensuring as high standards as possible, as people we are fallible and capable of inconsistencies and errors.

In this regard, for me, the Tenerife disaster is a classic showcase of the worst of human piloting failings: time pressures, environmental stress and arrogance contributed to the outcome, none of which would be experienced by computers.

Whilst programme engineers are still capable of making mistakes, possible crises can be considered, tested and double checked in advance. Whilst there will always be anomalies, advancements in AI will allow computers to learn and apply previous experience to new situations.

There will be challenges in adoption by users, though the current generation of young adults has grown up with technology in their lives on a scale never seen before and it is logical to see how they would embrace aircraft automation. However, as with all developments, adoption increases as the technology becomes more visible and with an expected safety record improvement, more sceptical users could be converted.

For underwriters, rating this technology would be complex and require extensive operational and security details to be provided, including what cyber protection is in place; this inevitably would raise premiums initially. However, we only need to look at the adoption of technology into the manufacturing industry to see the proven safety and reliability benefits.

In respect of automated air taxis, this is technology that may well be available in the coming years in such self-governing locations as Dubai. However, with the infrastructure and international liaison required in respect of automated airlines, we are still decades away.

Human pilots are a scarcening, expensive resource responsible for 70-80% of aircraft accidents and I believe that taking the human pilot out of an aircraft would improve aircraft safety and consequentially, underwriters' loss ratios.

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