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Vol. XXIII No. 5

Atlas Air Flight 3591: Spatial Disorientation

Drones

Aviation & Sustainability

Contents

Federation of Indian Pilots

FIP JOURNAL

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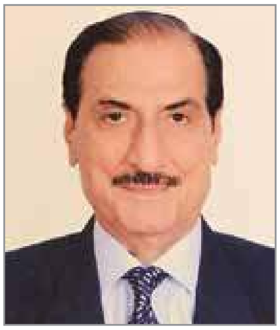
Message from the President



IN THIS MOMENT OF CRISIS,
THE FEDERATION OF INDIAN PILOTS STANDS FIRMLY BEHIND YOU.

Aviators have unflinchingly served the nation in the midst of the crippling Covid-19 pandemic and enabled many relief and rescue operations. In the last one year an aviator's service to the country took various shapes and forms. From repatriating citizens stranded overseas by operating Vande Bharat flights to airlifting critical supplies across the country, our members went above and beyond the call of duty to fight this bio hazard.

This is one battle where the hidden enemy comes home with the warrior. As a result, not just our members but some of their families too contracted this deadly virus. We lost many colleagues and their loved ones to this disease. We will forever remember your sacrifice in the service of the nation.

A vaccine is the only way to safeguard against this disease. We reached out to the highest level of government and impressed upon them the need to categorize pilots as frontline workers. This would have ensured that all pilots regardless of age could get vaccinated. Given the urgency of the matter, the FIP has approached the judiciary by filing Public Interest Litigation at Bombay High Court to ensure that pilots who are risking their lives for the country are treated on par with frontline workers. This includes adequate insurance coverage, availability of vaccines, alternate employment and an ex-gratia to the families of deceased pilots.

While vaccinations help reduce the severity of the disease, the best defense is not to get the disease at all. To this end we are constantly working with the government to reduce the occupational hazards for pilots. Routine breath analyser tests are a great source of concern, as these testing machines are often used on multiple individuals some of whom may be asymptomatic. Disposal of potentially infected blow tubes in the testing area, by some operators, could also amplify the risk of spreading the virus. Unmasking of aircrew while undergoing the BA test and consequent dangers of exposure to virus-laden aerosols could also spread the virus further.

Keeping in mind these dangers to pilots, the FIP reached out to the Director General of Civil Aviation and requested that BA tests be temporarily suspend as had been done on previous occasion. This will go a long way in ensuring that our pilots stay safe.

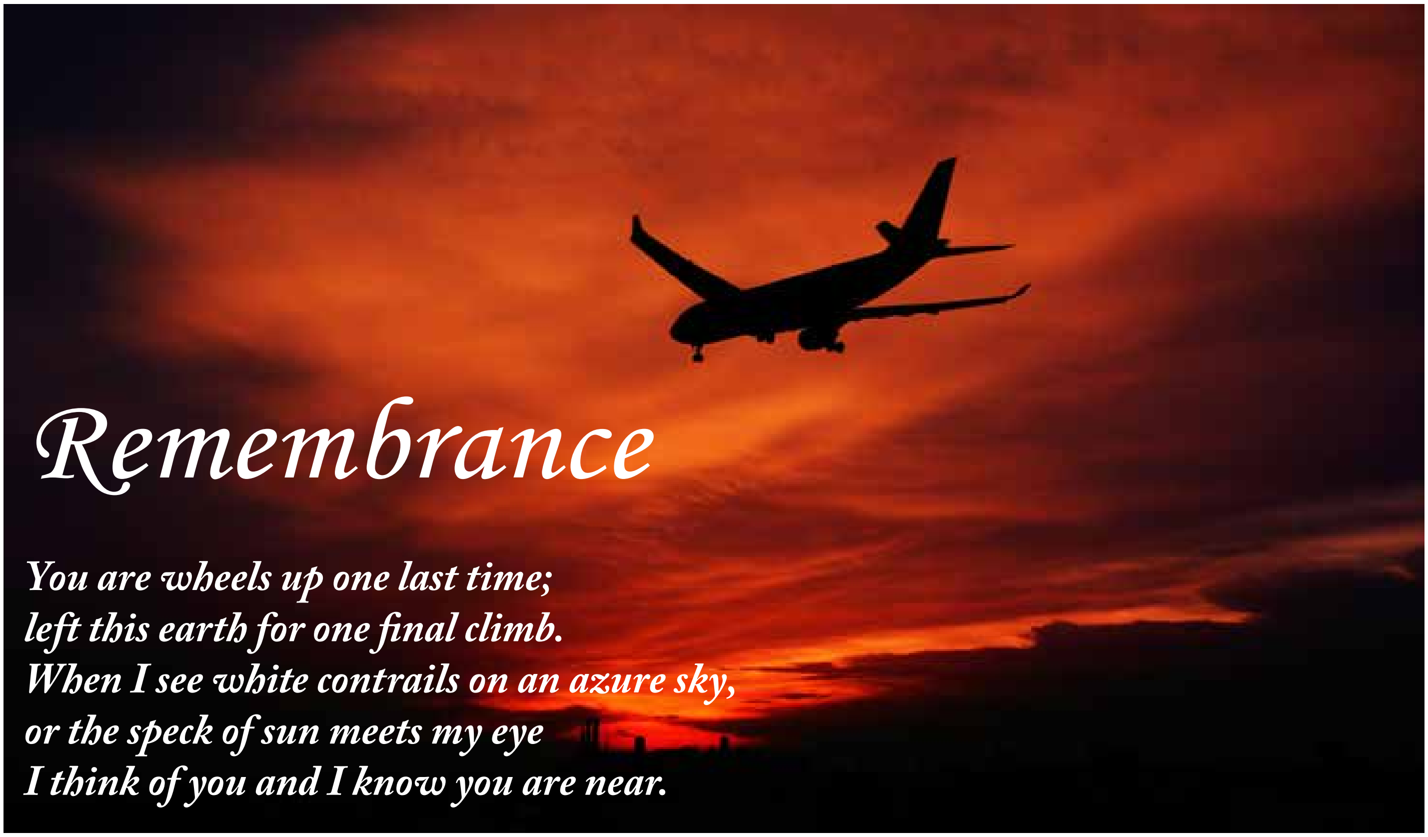
While, we are constantly working with the government to ensure the safest possible working environment, we are equally concerned about safeguarding the best interests of our pilots. Hence, this year we brought on board a new vendor for the Loss of License (LoL) insurance policy.

Though the FIP office is working under severe restrictions, the team is always available and eager to resolve any issue that our members may face.

We pray for your safety and your loved ones in these difficult times.

Happy Landings

- Capt S Mehta
President



Remembrance

You are wheels up one last time;
left this earth for one final climb.
When I see white contrails on an azure sky,
or the speck of sun meets my eye
I think of you and I know you are near.

The Corona pandemic has spread like wild fire and no corner of the country has been left untouched. In these difficult times, air transport becomes a vital link for those who need to travel at a moment's notice. As discretionary travel ground to a halt, all who were left in the cabin were people traveling out of great personal or professional need. In the middle of this crisis where it was every man for himself, getting out of the house once was frightening enough for most people. To keep the country connected and the wheels of the economy turning, pilots and flight crews went to work at grave personal risk. This risk was elevated many folds when, despite working around the clock to keep aircraft flying, pilots were not classified as frontline workers.

Though pilots are extremely fit individuals who are subject to stringent medical tests, if the immune system is not trained by vaccination, it can still loose the fight. Sadly, this has been the case for a number of our member pilots who have been seriously affected by this disease.

In this moment of numbing grief, we pray for the departed souls who left for their heavenly abode. The Federation shall do all that it can to support the bereaved families in this difficult time. FIP

It is with great regret that we inform you of the demise of our fellow aviators, who lost the battle with the corona virus.

- Capt. Sundeep Blaggana
- Capt. Rana Rajinder Pal Singh-6E
- Capt. Ramandip Bhati-G8
- Capt Krish Nagarath- SVA
- Capt Amitesh Prasad.- AI
- Capt Vidhya Sagar-6E
- Capt Sandeep Rana -AI
- Capt Gurpratap S Gill - AI
- Capt S Bhushan- 6E
- Capt Nazir Aziz -G8
- Capt Sumeet Mehta - UK
- Capt Sultan Singh
- Capt Harsh Tewary

Do not look at my grave and cry.
I am not there, I'm up in the sky.
I've passed my final checkride.
And now I'm free to fly.
To places I've only dreamed of,
while flying mortals through the sky.
Do not grieve for me, for I'm free to fly.
Do not grieve for me, for I did not die.
I just joined the flying club in the sky.

Developments

Development of health system capacities at airports under the Atma Nirbhar Swasth Bharat Yojana

Under a new centrally sponsored scheme, PM Atma Nirbhar Swasth Bharat Yojana, Union budget 2021-22 proposes development of health systems capacities in the country which also includes the aviation entry points. Under this program Public Health Units will be strengthened at 32 airports. This program will facilitate smooth movement of pharmaceuticals through air across India as well as in other parts of the world.

Expansion of scope for Krishi Udaan in convergence with Operation Greens:

To boost value addition in agriculture and allied products and their exports, the scope of 'Operation Greens Scheme' that is presently applicable to tomatoes, onions, and potatoes, will be enlarged to include 22 perishable products. Krishi Udaan Scheme stands converged with Operation Greens through air freight subsidy of 50% for the agri-perishables of NER States and 4 Himalayan States/UTs. The expansion of product-coverage will boost the Krishi Udaan Scheme and improve air cargo transportation from these States.

Hisar Airport Inaugurated Under RCS-UDAN

First flight to the newly constructed Hisar airport in Haryana from Chandigarh was flagged off today under the Regional Connectivity Scheme – Ude Desh Ka Aam Nagrik (RCS-UDAN) of the Government of India. The flight was flagged off by Shri Manohar Lal Khattar, Chief Minister, Haryana. The inauguration was attended by the senior officials of the Ministry of Civil Aviation (MoCA) & Airport Authority of India (AAI). The flagging off marks the operationalization of 54th airport under the UDAN scheme. To date, 307 routes and 54 airports including 5 heliports and 2 Water Aerodromes have been operationalized under the UDAN scheme.

Belonging to the Government of Haryana, Hisar airport is a public licensed airport that is suitable for 18 seater aircrafts. The development of the Hisar airport was undertaken by the MoCA as it aligns with the dual objectives of the UDAN scheme; "letting the common citizen of the country fly" & make air travel affordable and widespread in the country." Subsequently, the Government of India sanctioned INR 28.60 crores for the development of the interim civil aviation operations. The land was handed over to the AAI for the up-gradation and development of the Hisar airport. The upgrade included the construction of the new terminal building, hangars, strengthening of the runway, installation of night-flying equipment, ATC, security equipment, etc at the Hisar airport.

The airline Aviation Connectivity & Infrastructure Developers Pvt. Ltd (Air Taxi) was awarded the Hisar – Chandigarh – Hisar route under the UDAN 4 bidding process. The airline has become the first startup airline of the country to assist the nation with Air Taxi services. These UDAN flights will reduce the journey time between Hisar to Chandigarh from 4.50 hours to a comfortable 45 minutes journey that too at an affordable fare since financial incentives in the form of Viability Gap Funding (VGF) is being provided from the Centre, State governments & airport operators to selected airlines to encourage operations from unserved and underserved airports under the scheme.

AAI observes Aviation Safety Awareness Week 2020

Airports Authority of India (AAI) commenced Aviation Safety Awareness Week 2020 (23rd November to 27th November 2020). The week-long celebration is being observed at all airports and ANS locations managed

by AAI across India.

Shri Arvind Singh, Chairman, AAI, requested all Regional Executive Directors & Airport Directors to be proactive and to devote time personally for monitoring safety performance of their respective region/station. Shri Singh further stressed that during Covid-19 situation in spite of reduced flight movements, it has been observed that wildlife/bird menace has increased at airports. Safety preventive measures should continue unabated irrespective of traffic volume.

To raise awareness on Aviation Safety, AAI will undertake various employee engagement programs at the airports and ANS stations like reviewing of documents and facilities, Mock exercises, preventive maintenance etc. Various social campaigns too will be rolled out to raise awareness on the issue. Banners and posters are being displayed across AAI offices and operational centres to educate both external and internal stakeholders on the significance of the Safety Awareness Week.

Shri Maneesh Kumar DDG, DGCA has emphasized to achieve long term objective of Zero fatality by the year 2030 as envisaged by ICAO in its Global Aviation Safety Plan (GASP-2020-22) through better managed safety systems of stakeholders.

First direct flight operations flagged off on Belgaum-Nashik route under UDAN

The first direct flight operations between Nashik (Maharashtra) and Belgaum (Karnataka) started today under the RCS-UDAN (Regional Connectivity Scheme - Ude Desh Ka Aam Nagrik) of the Government of India. Operationalizing of this route expands the aerial connectivity of Belgaum to the 10 destinations across India. The Belgaum airport has emerged as the third busiest airport in terms of traffic in the state, after Bengaluru and Mangaluru. Officials of the Ministry of Civil Aviation (MoCA) and Airport Authority of India (AAI) were present at the launch of the flight operations. Till date, 311 routes have been operationalized under the UDAN scheme.

Several requests were received to start Belgaum-Nashik route considering the non-availability of any direct flight/train operations between these cities, till date. People were forced to travel by road & suffer a long journey of more than 10 hours. Nasik is a big tourist and business destination. Being one of the four pilgrimage sites that organises Kumbh Mela, and the gateway city for the Shirdi Sai Temple & Trimbakeshwar Temple, the city attracts lakhs of tourists every year. Additionally, due to the presence of majority of India's vineyards and wineries in the city, Nashik is also known as the Grape and Wine capital of India and attracts business community. Further, many people use this route to visit Kolhapur & Goa for tourism and business purposes. Now, these people can travel at ease by opting for a flight of just 60 minutes.

Star Air was awarded the Belgaum-Nashik route during the UDAN 3 bidding process. The airlines are being provided Viability Gap Funding (VGF) under the UDAN scheme to keep the fares affordable & accessible for the common people. The airline will be operating thrice-weekly flights on the route and will deploy its 50-seater Embraer ERJ-145 aircraft.

Dear Students,

This is to inform you that the phone numbers at the Institute of Aviation and Aviation Safety have been recently changed and are now active.

Kindly make a note of the new phone numbers :

8097461326 Whats App Number

8097461327

8097461328

Disregard all other numbers you may have for contacting the institute.

The office at the institute is open from 10 am till 5 pm on Monday to Friday only.

The institute will be closed on all Saturdays, Sundays and all Public holidays as announced by Mumbai University.

You are requested to get in touch with the staff at the institute on the above mentioned numbers only.

Regards,

Team IAAS

Understanding the Drone Revolution

The origins of modern drones go back six decades to the early 1960s, when radio-controlled hobby aircraft became widely available in the western world. The introduction of these aircraft was made possible by advances in radio technology at the time. While these aircraft were available to the general public, their audience was limited to enthusiasts, who were willing to put in the time and money needed to understand and operate these sophisticated machines.

One of the main challenges in these machines was learning how to operate and maintain the complex glow engines that were specifically designed for these applications. Though powerful, these engines were noisy and polluting, which meant that such planes needed to be operated far away from populated areas. Then there were the bulky and power-hungry radios that had limited range. Many model aircraft crashed after they lost contact with the transmitter.

Finally, there was the complexity of flying itself. without any electronic aids, the model aircraft had to be trimmed correctly and flown accurately without the benefit of a first-person view.

Despite these challenges there were a significant number of enthusiasts that took to radio controlled aircraft. Consequently, there existed an ecosystem that served the needs of this niche market. Kolkata, was one of the early Indian hubs for this hobby and it eventually spread to other metro cities by the 1990s.

Despite being overshadowed by drones that have now come to take center stage, the hobbyist radio control aircraft ecosystem continues to thrive. Models have gotten more complex and several are now powered by jet engines. These high-end models can cost several thousand dollars and can achieve speeds as high as 500 mph. Needless to say, most require a special FAA license to fly them.

Technology Shifts

While the introduction of drones into our everyday life can be best described as explosive and sudden, the technologies that underpinned this revolution grew at a more linear pace.

Electric propulsion systems

Electric motors are lightweight, have few moving parts and are extremely durable. However, for a large part of the 20th century they simply lacked the power to weight ratio to be used for such applications. A significant step forward in motor design came with the invention of the brushless DC motor in the 1960s. However, it would take over four decades of advancements in control electronics and metallurgy before these motors became a viable choice for drone manufacturers .

The Glow Engine

A glow plug engine, or glow engine, is a type of small internal combustion engine typically used in model aircraft, model cars and similar applications. The ignition is accomplished by a combination of heating from compression, heating from a glow plug and the catalytic effect of the platinum within the glow plug on the methanol within the fuel.

The glow plugs used in model engines are significantly different from those used in full-size diesel engines. In full-size engines, the glow plug is used only for starting. In model engines, the glow plug is an integral part of the ignition system because of the catalytic effect of the platinum wire. The glow plug is a durable, mostly platinum, helical wire filament recessed into the plug's tip. When an electric current runs through the plug, or when exposed to the heat of the combustion chamber, the filament glows, enabling it to help ignite the Glow fuel used by these engines.

Glow fuel generally consists of methanol with varying degrees of nitromethane content as an oxidizer for greater power, generally between 5% and 30% of the total blend. These volatiles are suspended in a base oil of castor oil, synthetic oil or a blend of both for lubrication and heat control

Today a number of motor/propeller combinations have an efficiency exceeding 70%. This is nearly twice the energy efficiency of a modern petrol engine.

The introduction of high efficiency BLDC motors was just half the puzzle, the other half was finding a suitable way to power them.

Energy Storage

Think of batteries and the first thought that comes to your mind are alkaline AA or AAA batteries. Indeed, these were the energy storage devices of choice for many years. The phenomenal growth in portable electronic devices has spurred the development and commercialization of a number of battery chemistries. Some of the initial battery chemistries included Nickel Cadmium and Nickel Metal Hydride.

Today, the industry standard is the Lithium Polymer or LiPo battery. As these batteries are used in a variety of applications they are produced at a massive scale. Consequently, they are incredibly cheap and have specific energies as high as 158 Watt Hours per kilogram. This represents a three-fold improvement over alkaline batteries.

With these energy dense batteries available at rock bottom prices, the efficient BLDC motor had found the perfect match.

Flight Control Electronics

Remember how one of the biggest challenges for hobbyists was actually flying the aircraft. This problem was solved not by leveraging the rigid laws for physics but rather by leveraging Moore's law of computing. As predicted, microchips became more powerful and energy efficient while simultaneously becoming cheaper to manufacture. About 15 years ago these chips finally became powerful enough to perform the complex calculations required by modern drones.

By writing a complex algorithm which is referred to as a flight controller, engineers were able

Understanding Quadcopters

A quadcopter or quadrotor is a type of helicopter with four rotors. Each rotor produces both lift and torque about its center of rotation, as well as drag opposite to the vehicle's direction of flight.

If all four rotors are spinning at the same speed, with two rotating clockwise and two counterclockwise, the net torque about the yaw axis is zero, which means there is no need for a tail rotor as on conventional helicopters. Yaw is induced by mismatching the balance in aerodynamic torques. This is achieved by offsetting the cumulative thrust commands between the counter-rotating blade pairs.

Quadcopters generally have two rotors spinning clockwise (CW) and two counterclockwise (CCW). Flight control is provided by independent variation of the speed and hence lift and torque of each rotor. Pitch and roll are controlled by varying the net centre of thrust, with yaw controlled by varying the net torque.

For small drones, quadcopters are cheaper and more durable than conventional helicopters due to their mechanical simplicity. Their smaller blades are also advantageous because they possess less kinetic energy, reducing their ability to cause damage. For small-scale quadcopters, this makes the vehicles safer for close interaction. It is also possible to fit quadcopters with guards that enclose the rotors, further reducing the potential for damage. However, as size increases, fixed propeller quadcopters develop disadvantages relative to conventional helicopters.

Increasing blade size increases their momentum. This means that changes in blade speed take longer, which negatively impacts control. Helicopters do not experience this problem as increasing the size of the rotor disk does not significantly impact the ability to control blade pitch.

Gimbals: The secret behind smooth drone videos

The gimbal was first described by the Greek inventor Philo of Byzantium (280–220 BC). It is A gimbal is a pivoted support that permits rotation of an object about an axis. A set of three gimbals, one mounted on the other with orthogonal pivot axes, may be used to allow an object mounted on the innermost gimbal to remain independent of the rotation of its support.

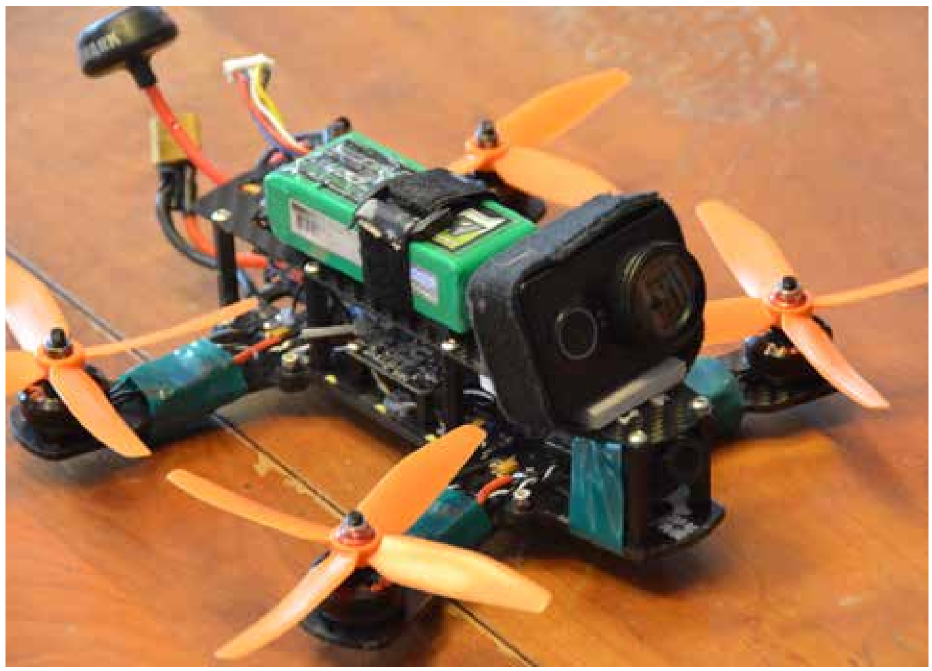
Mounting cameras on drones use the same concept but with one notable difference. Sophisticated electronics now allow the drone operator to control the onboard camera independent of the motion of the drone. To do this a sophisticated IMU detects changes to the drone's orientation in real time, any changes in the drone's position are quickly relayed to control unit that then adjust the position of each ring in the gyro with the help of small motors.

to get microchips to do much of the hard work of flying. This also opened the avenues to design complex aircraft configurations that were previously beyond the capabilities of human control.

Today an inexpensive "computer" can not only control the drone, but also perform several secondary functions such as processing video feeds, controlling external sensors and ensuring that the drone does not hit any obstacle.

Supporting Developments

One of the key developments in the evolution of drones was the miniaturization of Inertial Measurement Units (IMU). The IMU is the critical sensory system for the flight controller without which the flight control algorithm simply cannot



obtain the inputs needed for flying the aircraft. Along with the development of the IMU, the miniaturization of GPS receivers greatly enhanced the ability to produce drones that are easy to fly.

Lastly improvements in wireless communications allowed for improved command and control at greater distances. These improvements subsequently enabled a real time video feed to the drone operator, making it possible to fly greater distances in a safe manner.

Though not directly related to building a drone, video sharing services allowed content taken from drones to travel around the globe and create demand that was based on utility rather than hobby.

DJI Phantom: The iPod Moment for Drones

Da-Jiang Innovations, popularly known as DJI, was founded in 2006 by Frank Wang, a student at the Hong Kong University of Science and Technology. From 2006 to 2013 the company launched several models that met with limited success in a nascent drone market.

All that changed in 2013 when the company launched the Phantom 1 drone in the United States market.

It's quadcopter design was easy to "fly" because the flight control algorithm actually controlled the vehicle. With the heavy lifting done by computers, all the operator had to do was command the drone to go up or down, left or right and rotate.

Its lithium-Ion battery pack gave it a usable flight time of 10 minutes. As the battery pack was easily swappable, most users simply carried multiple battery packs for extended flight times.

The initial control system was similar to those used for RC flying but much simpler. It was able to eliminate the need for trimming wheels and for the need to hold the throttle at a certain level. With the on-board GPS system, the Phantom could hold its position in three-dimension space without any external control. If the drone ever went out of the operator's sight or lost control with the control system, it would simply fly back to the start position and land itself.

In addition, the Phantom could carry a GoPro action camera. This found it a niche market among adventure sports enthusiasts who were already using the camera to capture and share their adventures. Needless to say as the videos went viral so did the demand for Phantom drones and the rest is history.

The phantom line of drones has been joined by others from the DJI stable and the company offers one of the most comprehensive lineup of consumer drones. Today DJI is synonymous with the word drone. It commands over 70% of the consumer drone market, its nearest rivals hold a mere 5% of the market.

Beyond Consumer Drones

The technologies that spurred the introduction of consumer drones continue to progress unabated. Consequently, drones too are becoming more capable with the passage of time. With their low cost of operation, ease of maintenance and high degree of autonomy, drones are excellent candidates for performing predictable tasks in dangerous environments. By deploying drones, companies across industries are looking to improve operating efficiencies and reduce costs.

Intel partnered with Airbus to conduct exterior aircraft inspections with UAVs. Intel supplied drones outfitted with cameras that allow them to collect images and data that can be used to create detailed, 3D-models of the Airbus fleet. Airbus has also launched its own drone subsidiary called Airbus Aerial, which looks to provide inspection services across a variety of industries.

Building Ecosystems

As we adapt drones to industrial use cases, there is bound to be an increase in drone complexity. In addition, the level of safety required of drone operations will be comparable to that of mainstream aviation operations. Thus, it is likely that businesses will outsource the actual operation of drones to a competent entity. The growth and development of such full service providers, will ensure that industries are able to leverage this new class of aircraft. In certain industries such as logistics the adoption of drones will hold the key to boosting efficiencies and remaining globally competitive.

The government has taken note of building such an ecosystem, and consequently the Centre-run flight training institute Indira Gandhi Rashtriya Uran Akademi (IGRUA) has announced its expansion plan to begin drone pilot training courses, a first of its kind initiative by a government body. The premier aircraft pilot training institute in Uttar Pradesh had recently entered into an agreement with Delhi-based private firm Drone Destination for the collaborative effort.

This is a huge step forward for the ecosystem. FP

Indira Gandhi Rashtriya Uran Akademi Inks Training Pact With Drone Destination

Government-run premier flying training institute, Indira Gandhi Rashtriya Uran Akademi (IGRUA) has inked an initial pact with Drone Destination to launch drone pilot training courses for aspirant professionals at the former's Amethi campus in Uttar Pradesh.

Drone Destination is a sister-concern of the Delhi-based remotely piloted aircraft (RPA) manufacturing firm Hubblefly Technologies.

Under the memorandum of understanding (MoU), the institute will provide its state-of-the-art infrastructure and Drone Destination its domain expertise in training drone pilots at the campus.

"This MoU enables both the organisations to provide the best drone training to aspiring drone professionals using IGRUA's state of the art infrastructure and Drone Destination's expertise in providing high quality, professional drone training," said Krishnendu Gupta, Director, IGRUA.

Drone Destination aims to develop an integrated eco-system for RPAs right from manufacturing to training, services insurance, leasing and finance, as per the release.

The robust training programs will create responsible industry-ready drone pilots who maintain the highest levels of safety and security of the sky, said Chirag Sharma, Founder and Chief Executive Officer, Drone Destination.

Drones: The Future Is Taking Place Now

Introduction

Drones, Drones, Drones and Drones. In just a few years drones have gone from being an obscure military term word to a buzz word in every part of life. It would be hard to find anyone in India who has not seen a drone or heard about them. Though we conversationally refer to these flying machines as drones, the technical term used by many is Unmanned Aerial System or UAS for short.

Drone - Joshua Goldman/CNET

Undoubtedly videography remains one of the most popular use cases for drones. But hidden away from the public eye, drones are adding immense value to diverse industries across the globe. For example, the New York Power Authority recently tested using drones to inspect an ice boom near Lake Erie. Inspecting one of these ice booms normally costs $3,500 to send a helicopter or $3,300 to send a boat to perform the task, but it costs less than $300 to deploy a drone.

Excitement, Passion & maybe Concerns?

As a professional aviator I am super excited about drones. With our shared passion for flying machines, I am sure that you share my excitement and passion for drones too.

That being said, do you share a tinge of concern be it failure of hardware, software, mechanical or even privacy? Are multiple thoughts racing through your mind? Of course there are since we understand the risks associated with being in the air more and better than most.

Pilots & The Ghost in the Machine

Aircrafts are becoming more complex and airspaces more dense. While autopilots are reliable, no system can ever be foolproof. Hence, it is essential to ensure that there is a well trained pilot sitting in the cockpit, who can react appropriately to any emergency.

On the other side of the equation, the exponential and continued growth of Artificial Intelligence, Machine Learning and wireless communications has enabled autonomous operations of UAS systems.

Given the diverse roles and applications of manned and unmanned systems, the two are likely to co-exist for the foreseeable future.

Where are the Drones Flying & for What Purpose?

Given their varied shapes and sizes, one can find drones in a wide variety of applications. Here are some of the more prominent use cases.

The Battle Front

The birth of drones goes back to World War-I. Back then the US Army placed an order for an unmanned "flying bomb" which could hit a target at a range of 64 kilometres. The kettering bug as it came to be known, made its first flight in October 1908 and met with limited success. Since then armies around the world have continued to employ drones for military purposes.

Today's military drones are highly sophisticated machines often being controlled from the other side of the world. With the pilots sitting safely in their home bases, these drones can venture over heavily defended areas and provide valuable information. Modern drones are capable of undertaking a variety of missions including, reconnaissance, close air support, homeland security and so on.

Drones like the General Atomics Predator have shot to fame thanks to the American media broadcasting exploits all around the world. These ghosts in the sky often stayed on station for hours stealthily stalking their target. When the time was right, these drones unleashed their precision guided munitions that decimated the target. With drones gathering so much attention from militaries across the world, the behemoths of the aerospace industry are putting their weight behind this class of aircraft. Consequently several billion dollars have been spent on research and development of advanced UAS concepts.

Boeing has a program called the Boeing Airpower Teaming System (ATS), also known as the Loyal Wingman project, which serves as a force multiplier, where unmanned airplanes fly together with manned fighters. As of March 2021, the loyal wingman has successfully completed maiden flight trials in Australia. The Indian Armed forces are also integrating drones into their arsenal. These include the IAI Heron, Searcher and Harpy Drones. In addition the Indian armed forces also use the Laskhya target drone developed by the

Zipline Drone dropping Supplies - Credit: Gavi/2`018/KAREL PRINSLOO

DRDO. The indegenous Rustom UAS is also under development.

Drones for Logistics

Drones have immense potential to disrupt traditional road and rail logistics, especially in remote areas where infrastructure is scarce. With their high degree of autonomy, moderate payload and high reliability, drones are well suited for delivery applications. Some early applications of this concept can be seen in places as far flung as Africa. Zipline, a California based company has successfully operationalized drone based delivery of medical supplies for critical patients in remote rural areas in Rwanda & Ghana.

In India, the Director General of Civil Aviation (DGCA) has given a nod to food startups like Zomato, Swiggy and Dunzo to start testing beyond the visual line of sight (BVLOS) drones for deliveries. Globally, a number of logistics companies such as Amazon's Prime Air and others like UPS & FedEx are exploring the use of drones to enhance their operating efficiency.

Drones for Agriculture

Drones are proving particularly useful in the agriculture sector, where their high resolution video feeds can help farmers monitor huge tracts of land. Advanced agricultural drones are often equipped with multi spectral imaging cameras that aid in identifying problems.

Drones were successfully used to assist in handling the locust menace that swept through parts of Rajasthan, Punjab and Haryana. Drones are also being developed for plant health monitoring, and eventually for spraying applications. This will eventually result in enhanced yield of crops.

Drones in India

Let's circle back to the questions raised regarding safety raised at the beginning of this article. Before the government can freely permit the use of drones, the aviation community must answer the question "What does it take to ensure that unmanned aircraft share the skies SAFELY with conventional manned aircraft?"

In a monumental move forward, the Indian Government through the Ministry of Civil Aviation, has published The UAS Rules, 2021. This is a continuation of the original CAR that was published in December 2018. These regulations pave the way for safe operation of drones in Indian airspace. The DGCA has deployed and continues to develop the Digital Sky platform.

Left to Right- Capt Kush Agarwal and Mr. Kiran Shah, of YelloSKYE

DigitalSky is a Ministry of Civil Aviation initiative, a highly secure and scalable platform which supports technology frameworks such as NPNT (No permission no take-off) designed for enabling flight permission digitally and managing Unmanned Aircraft operations and traffic efficiently. This platform ensures that drones are properly registered and are only operated by trained operators in an authorized airspace. Drones have also been categorized into weight categories, and minimum standards of equipment and licensing for each category have also been defined. The Indian regulatory framework along with the Digital Sky platform is one of the most comprehensive pieces of governance in the world.

Building a world class governance structure is only the tip of the iceberg. Behind the scenes the drone ecosystem in India is coming to life. Crucial players in this ecosystem include drone manufacturers, trained operators, pilot training organizations, maintenance organizations, specialist software developers and drone data analytics platforms. These parts of the ecosystem are becoming operational in preparation for a full-fledged unmanned aircraft industry.

The Future is Taking Place Now

With their unique capabilities and immense commercial potential, drones are here to stay. Advanced analytics, machine learning and other cutting edge technologies shall drive us towards a future where a significant portion of aviation is unmanned.

If the drone show of the 2021 Tokyo Olympics feels like it was taken from a science fiction movie, then clearly the Future is Taking Place Now.

YelloSKYE

YelloSKYE is a professional company that offers consultancy and operational expertise on drones. Its management team comprises experts in commercial aviation, banking, capital markets, and deep technology including AI and ML. The objective at YelloSKYE is to build professional, safe and scalable drone operations for India.

Watch this space for your regular dose on Drones.FIP

Electric Flying Taxis Coming to Los Angeles in 2024

Los Angeles is fast becoming the epicenter for electric air taxis, aka the flying cars of the future. Two companies Joby Aviation and Archer are developing VTOL aircraft that can be deployed for commercial air taxi services in the Los Angeles region as soon as 2024.

Joby Aviation

Joby Aviation is a California headquartered transportation company. Founded in 2009, Joby employs more than 700 people, with offices in Santa Cruz, San Carlos, and Marina, California, as well as Washington D.C. and Munich, Germany.

The zero emissions aircraft, which is quiet at takeoff and near silent when flying overhead, can transport four passengers and a pilot up to 150 miles on a single charge and can cruise at 200 mph. Joby hopes its aircraft will help reduce urban congestion and accelerate the shift to sustainable modes of transit.

Joby Aviation plans to launch commercial operations in the United States in 2024, before scaling its service globally. Air taxi networks can be scaled rapidly and efficiently using existing heliport or airport infrastructure, with the number of routes in a network growing exponentially as new vertiports are introduced.

In 2020, Toyota Motor Corporation led Joby's $620 million Series C round, forming a strategic partnership that sees Toyota engineers working shoulder-to-shoulder with Joby on projects such as factory layout and manufacturing process development.

Joby Aviation also recently finalized the terms of an enhanced relationship with Uber Technologies, Inc. that sets Joby apart in terms of commercial readiness. Under the agreement, the companies will integrate their respective services into each other's apps, enabling future customers to enjoy seamless multi-modal travel. Joby also acquired Uber Elevate, a division of Uber focused on the aerial ridesharing market.

In December 2020, the US Air Force granted Joby Aviation its first ever airworthiness approval for an eVTOL aircraft as part of its Agility Prime program, designed to accelerate the commercial adoption of electric aviation.

Earlier this month, Joby announced that it had agreed to a "G-1" certification basis for its aircraft with the Federal Aviation Administration. Formalized in 2020, the agreement specifies the requirements that need to be met by Joby's aircraft for it to be certified for commercial operations.

Joby is the first eVTOL aircraft to have achieved this milestone, marking a watershed moment for the industry and providing a clearly defined path for the certification of its aircraft.

Construction is expected to begin on a 450,000 square foot manufacturing facility, designed in conjunction with Toyota, later this year.

Archer Aviation

Based in Palo Alto and led by co-founders and co-CEOs Brett

Adcock and Adam Goldstein, Archer is developing a commercially viable all-electric UAM platform that will move people throughout the world's cities in a fast, safe, sustainable, and cost-effective manner. The fully electric vertical takeoff and landing aircraft is expected to be capable of traveling distances of up to 60 miles at 150 mph using technology available today.

United Airlines has announced that it has entered into an agreement to invest in Archer as part of the airline's broader effort to partner with leading technology companies that will decarbonize air travel. Under the terms of the agreement, United has placed an order, subject to United's business and operating requirements, for $1 billion of Archer's aircraft, with an option for an additional $500 million of aircraft. United, in partnership with Mesa Airlines, could give customers a quick, economic and low-emission way to get to airports within its major hubs by 2024.

United estimates that using one of Archer's eVTOL aircraft could reduce CO_2 emissions by up to 50% per passenger on a trip between Hollywood and Los Angeles International Airport (LAX), which is one of the initial cities Archer plans to launch their fleet and one of United's largest hubs.

In January 2021, Archer announced it had entered into a strategic collaboration agreement with Stellantis, with a focus on accessing its low-cost supply chain, advanced composite material capabilities, and engineering and design experience. FTP

Atlas Air Flight 3591

On February 23, 2019, at 1239 central standard time, Atlas Air Inc. (Atlas) flight 3591, a Boeing 767-375BCF, N1217A, was destroyed after it rapidly descended from an altitude of about 6,000 ft mean sea level (msl) and crashed into a shallow, muddy marsh area of Trinity Bay, Texas, about 41 miles east-southeast of George Bush Intercontinental/Houston Airport (IAH), Houston, Texas.

The captain, first officer (FO), and a nonrevenue pilot riding in the jumpseat died. Atlas operated the airplane as a Title 14 Code of Federal Regulations (CFR) Part 121 domestic cargo flight for Amazon.com Services LLC, and an instrument flight rules flight plan was filed. The flight departed from Miami International Airport (MIA), Miami, Florida, about 1033 (1133 eastern standard time) and was destined for IAH. A review of cockpit voice recorder (CVR) and flight data recorder (FDR) data determined that the flight's departure from MIA, en route cruise, and initial descent toward IAH were uneventful. The FO was the pilot flying (PF), the captain was the pilot monitoring (PM), and automated flight functions (autopilot and autothrottle) were engaged.

At 1230:37, when the flight was about 73 miles southeast of IAH and descending normally through about 17,800 ft msl, the captain checked in with the Houston terminal radar approach controller and reported that the flight was descending toward the airport on the assigned arrival route. At 1234:09, the approach controller advised the flight crew of an area of light-to-heavy precipitation about 35 miles ahead of the flight's position and that they could expect vectors to navigate around it. The FDR data showed the flight continued to descend normally on the assigned arrival route.

According to CVR audio, at 1236:07, the FO said, "okay – I just had a…," then, 3 seconds later, he initiated a positive transfer of airplane control to transfer PF duties to the captain, stating, "your controls." The captain responded, "my controls." At 1237:07, the FO made a comment about the electronic flight instrument (EFI) switch. Two seconds later, the FO said, "okay, I got it back," and the captain said, "now it's back." The FO then said, "I press the EFI button, it fixes everything," and the captain acknowledged

While acting as PM, the FO advised

the air traffic controller that the flight would like a vector west of the weather and acknowledged the controller's instructions for the flight to "hustle all the way down" in its descent to 3,000 ft msl.

As the airplane continued its descent, the speedbrakes were extended. The controller advised the flight to turn left to 270°, which the captain acknowledged before transferring PF duties back to the FO at 1237:24. After the FO resumed PF duties, the CVR recorded comments between the FO and the captain that were consistent with setting up the flight management computer (FMC) and configuring the airplane for the approach to IAH, including lowering the slats (consistent with the "flaps 1" setting). The FDR data showed that the airplane continued to descend normally until 1238:31, when the airplane's go-around mode was activated.

At the time, the airplane was about 40 miles from IAH at an altitude of 6,300 ft msl. During the next 6 seconds, the airplane's automated flight functions commanded nose-up pitch and an increase in engine thrust, consistent with go-around mode-driven commands. Neither crewmember made any callout to indicate intentional activation of the go-around mode or took action to disconnect the automation. The captain continued to receive and respond to routine air traffic control (ATC) communications. About 1238:36, the speedbrakes were retracted, then the airplane's elevators moved in response to manual control inputs to command nose-down pitch. The amount of nose-down pitch continued to increase, and the airplane entered a steep descent. Beginning at 1238:44, the FO said, "oh," then said in an elevated voice "whoa… (where's) my speed, my speed…we're stalling;" he then exclaimed "stall" at 1238:51. A review of FDR data determined that the airplane's airspeed and pitch parameters were not consistent with the airplane at (or near) a stalled condition, and none of the stall warning system indications activated. At 1238:56, the captain asked, "what's goin' on?" Three seconds later, the pilot riding in the jumpseat shouted, "pull up." About this time, the elevators moved consistent with manual control inputs to command airplane nose-up pitch. The nose-up pitch control inputs were held for the remaining 7 seconds of the flight but were unsuccessful in arresting the airplane's descent in time to prevent its crash into the marsh (see figure 1).

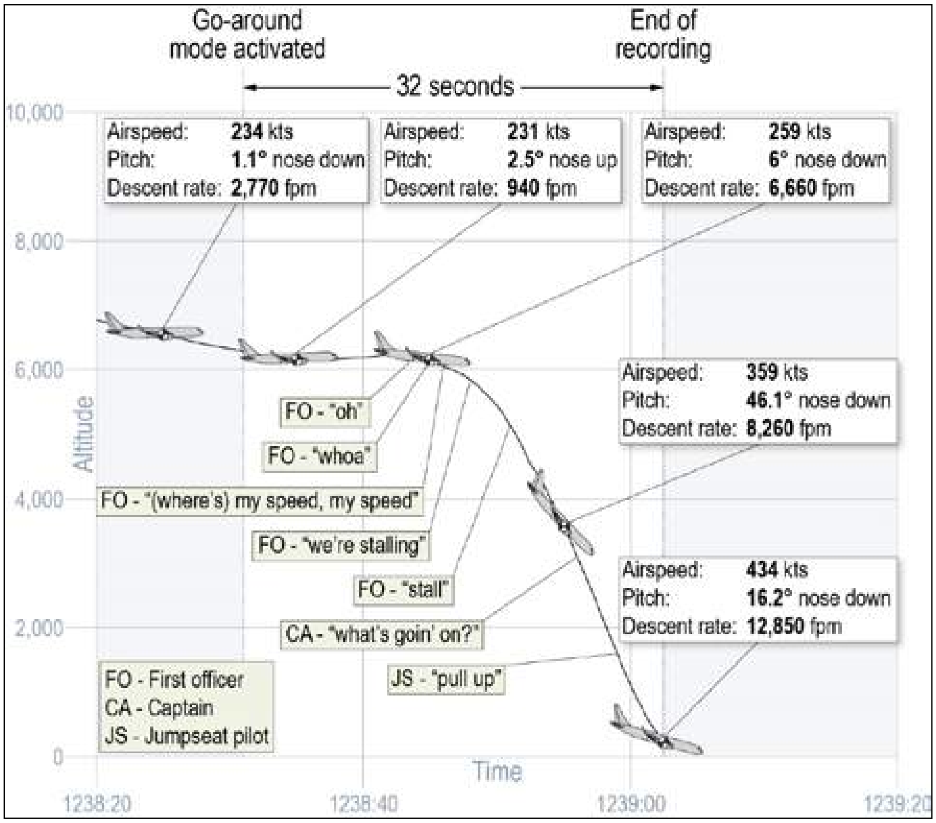
Tests and Research

Airplane Performance Study

The NTSB's airplane performance study used FDR data, automatic dependent surveillance-broadcast data, and CVR information to evaluate various airplane parameters recorded during the flight. (Basic airplane systems information is included in this section for context.) Before the go-around mode was activated, the airplane was descending normally at a reduced thrust setting (thrust levers were about 32° to 33°) with an airplane pitch attitude of about 1° nose down and operated with the autopilot and autothrottle engaged. The airplane's automated flight control system could perform climb, cruise, descent, and approach functions as selected by the flight crew using the mode control panel (MCP), FMC, and thrust mode selector.

The FDR data indicated that the crew had the assigned altitude of 3,000 ft msl selected using the MCP. FDR data showed that airplane vertical load factor variations began about 1238:25, with a peak vertical acceleration of 1.26 gravitational acceleration (g), the flight was in the immediate vicinity of the leading edge of a cold front at the time.

FDR data at 1238:31 showed that the airplane's automated flight system status for the go-around mode changed to "activated," and the CVR recorded a "click" at this time. In the accident, the airplane's configuration with autopilot and autothrottle engaged, the autopilot/flight director system (AFDS) and autothrottle would be expected to respond by controlling airplane pitch, roll, and thrust to maintain ground track, hold the existing airspeed, and establish a climb rate of at least 2,000 ft per minute. During the next 6 seconds, automated flight commands advanced the thrust levers to about 80° to 82°, resulting in increased thrust and longitudinal acceleration, and moved the control column and elevators to command nose-up pitch; during this time, the airplane's pitch increased to about 4° nose up.



About 1238:36, the speedbrake lever was moved from the extended position to the armed position, which retracted the speedbrakes. Recorded airplane parameters at this time, including those for air/ground sensing and flap setting criteria, did not meet the conditions for automatic speedbrake retraction. Between about 1238:38 to 1238:56, the airplane pitched nose down and continued to accelerate, reaching a peak longitudinal acceleration of 0.27 g at 1238:42.

During this time, the position of the left elevator control column (the only side for which the FDR recorded position data) matched the position of the elevators, which was consistent with the elevators responding to manual inputs from a crewmember on an elevator control column.

Such a manual override of the autopilot would require control column inputs in excess of 25 lbs. The airplane's nose-down pitch during this time progressed rapidly to about 49° nose down, and the airplane entered a steep descent. At 1238:40, the CVR recorded a beeping sound consistent with the "owl" beeper; the FO then said, "oh" at 1238:44 and "whoa" at 1238:45.27 Between 1238:46 and 1238:56, the right elevator was in a more airplane nose-down position than the left elevator, which would be consistent with the captain and the FO each applying differing manual inputs on their respective control columns.

At 1238:48 and 1238:51, the FO stated that the airplane was stalling. Review of the airplane's recorded vane angle of attack (AOA), which was below -15°, and airspeed, which was above 250 knots (kts), determined that the airplane's wing stall AOA was not exceeded, and the airplane was not at or near a wing-stalled condition. Also, the FDR's recorded parameter for the stick shaker did not record the stick shaker as being active at any point in the flight. Beginning about 1238:45, the thrust levers were reduced to 33° within 1 second then increased to about 80° to 85° within 2 seconds. These rates of thrust lever movement were faster than the autothrottle system could command.

At 1238:56, the captain asked, "what's goin' on?" At the time, the airplane was descending through an altitude of about 3,000 ft msl, and both elevators began to move concurrently toward an airplane nose-up position. About 2 seconds later, both elevators attained the full airplane nose-up position and remained there until the end of the FDR recording.

During this time (beginning at 1238:56), a series of beeps consistent with the "siren" sounded, and the FDR recorded an overspeed.

Just before the FDR recording ended at 1239:03, the airplane's pitch was about 20° nose down, its airspeed was in excess of 400 kts, and its load factor was more than 4 g.

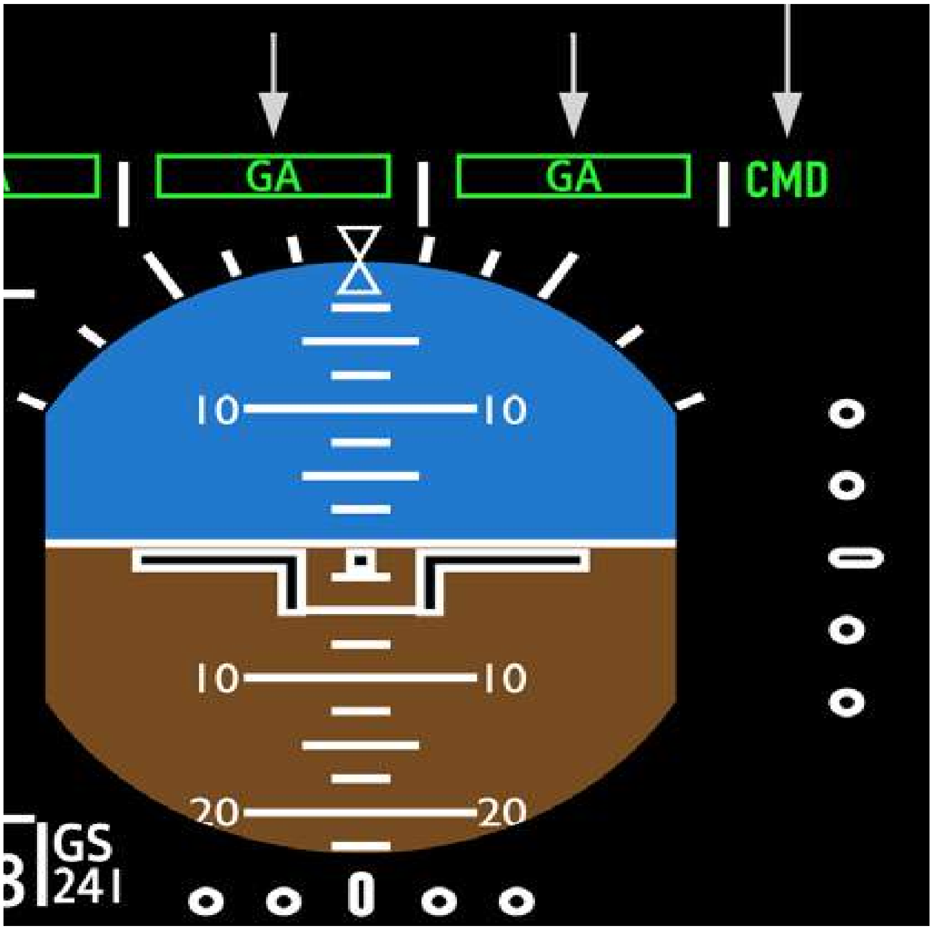
Boeing 767 Simulator Scenario Observations

Investigators performed a series of scenarios in a Boeing 767 full-flight simulator to document various indications, alerts, and airplane responses related to operation of the autopilot, autothrottle, go-around switches, speedbrake handle, and EFI switch. The scenarios were flown by a PF in the right seat to enable investigators to observe how a pilot seated on that side of the airplane interacted with the various airplane controls and displays. In one scenario, the PF was expediting a descent to 3,000 ft msl (with 3,000 ft msl set on the MCP) with the speedbrakes extended and the autopilot and the autothrottle engaged. At 6,400 ft msl, the PF pushed one of the go-around

switches. The investigators observed that the airplane responded by climbing and the speedbrakes did not automatically retract. Concurrent with go-around mode activation, the flight mode annunciator at the top of each ADI display annunciated "GA/GA/GA/CMD" in green (with a temporary box around each "GA") to indicate, respectively, that the go-around mode was active for autothrottle, pitch, and roll and that the autopilot function of the AFDS was engaged.

According to Atlas' flight crew operating manual (FCOM), when using the speedbrakes during flight, "the PF should keep a hand on the speedbrake lever…This helps prevent leaving the speedbrake extended when no longer required." One Atlas pilot interviewed said that, in his experience, the "overwhelming majority [of pilots] if not almost everybody" followed this procedure.

Investigators performing the simulator scenarios had the pilot hold the speedbrake lever using a variety of different hand grip and arm positions. The investigators observed that, when the right-seat PF kept his left hand on the speedbrake lever during the descent (consistent with Atlas' procedures), the PF's left hand and wrist could be under the thrust levers and close to the left goaround switch. (The distance between the hand/wrist and the go-around switch varied with different hand grip and arm positions.) The scenarios showed that, if a PF were wearing a watch on the left wrist (as photographs showed the accident FO had done at times), this could result in decreased clearance beneath the go-around switch (see figure 12). Investigators also observed that cycling the EFI switch (to reset the respective SG) took less than 4 seconds to accomplish, did not change the ADI's presentation of the airspeed data, and did not affect the information displayed by the two conventional Mach/airspeed indicators.



Events Involving Inadvertent Go-Around Mode Activation

In response to NTSB requests for data about any reported events involving inadvertent activation of the go-around mode on Boeing 767-series airplanes, The Boeing Company, Atlas, one other domestic airline (among several contacted), and the National Aeronautics and Space Administration's (NASA) Aviation Safety Reporting System (ASRS) identified no such reports in their respective databases. The ASRS database contained 11 reported events of inadvertent goaround activation that occurred between 1990 and 2017 involving other airplane models, including Boeing 737-, 747-, and 777-series; Airbus A320; Bombardier CL-600; and Embraer EMB170 airplanes.35

A review of these ASRS reports revealed that each flight crew was able to correct the situation, but some experienced undesirable results, such as altitude deviations, a missed crossing restriction, and a flap overspeed. One event, which involved a flight crew on a Boeing 747, progressed to stick shaker activation before they regained situational awareness and corrected the condition. The NTSB is aware of two 1994 accidents and a 1989 incident that involved transportcategory airplane models other than the Boeing 767 and included inadvertent activation of the goaround mode in the sequence of events.

Terrain Awareness and Warning System Simulation

The airplane was equipped with a Honeywell enhanced ground proximity warning system, which is a terrain awareness and warning system (TAWS) designed to reduce the risk of controlled flight into terrain by providing flight crews with alerts and warnings about potential terrain conflicts. The unit was not located in the wreckage, and FDR data showed that all parameters related to TAWS alerts remained "off" for the entire accident sequence. A simulation of TAWS functions performed by the manufacturer using data from the accident flight found that the change in radio altitude values near the end of the FDR recording was considered excessive by the system, which flagged it for internal reasonableness. The system's logic flag caused the simulation to disregard the radio altitude data for 3 seconds. The simulation found that, due to this logic flag and another associated with the rapidity of the accident flight's descent, the FDR recording ended before a TAWS alert would have been issued.

Flight Crew Performance

Before the inadvertent activation of the go-around mode, the airplane was descending to a target altitude of 3,000 ft msl, and the flight crew would have been expecting the airplane's automation to increase thrust and increase pitch slightly from about 1° nose-down to level off once the flight reached that altitude. However, once the go-around mode was inadvertently activated about 6,300 ft msl, the airplane's automation advanced the thrust levers and increased the airplane's pitch to about 4° nose up to initiate a climb. In addition, the flight mode annunciator changed to indicate go-around mode activation by illuminating "GA/GA/GA/CMD."

The unexpected mode change associated with the inadvertent go-around mode activation (and the higher altitude at which it occurred) would have been recognizable to the FO and the captain through an effective instrument scan. Both the flight mode annunciator and the engine indicating and crew-alerting system (EICAS) would have displayed "GA" indications, and the altimeter would have indicated about 6,300 ft msl. According to Atlas' procedures, the expected crew response to unwanted operation of automated flight systems was to disconnect the automation. However, neither the FO nor the captain ever acknowledged that the airplane had transitioned to go-around mode or disengaged the autopilot or autothrottle. Thus, the NTSB concludes that, despite the presence of the go-around mode indications on the flight mode annunciator and other cues that indicated that the airplane had transitioned to an automated flight path that differed from what the crew had been expecting, neither the FO nor the captain were aware that the airplane's automated flight mode had changed. Research has shown that pilots can miss changes in displayed modes, particularly those that are unexpected (Mumaw et al 2000), and other factors (discussed in the next sections) may have reduced the effectiveness of each crewmember's scan

First Officer's Incorrect Response Following Unexpected Mode Change Although the FO did not verbalize awareness that something unexpected had happened until about 13 seconds after go-around mode activation (when he said "oh" and then "whoa" in an elevated voice), manual control inputs that began sooner suggest that the FO (as PF) had sensed changes in the airplane's state and had begun to react without fully assessing the situation. The manual retraction of the speedbrakes 5 seconds after go-around mode activation was likely performed by the FO (as PF) instinctively once he felt the increased load factor from the airplane leveling off and heard and felt the engine thrust increasing. He had likely been anticipating the need to perform this task when the airplane leveled off. However, beginning about 1 second later, as the airplane's acceleration and upward pitch began to increase (which would have resulted in the aft movement of the GIF vector sensed by the pilots), manual forward control column inputs were applied, overriding the small, autopilot-driven pitch-up command and resulting in decreasing pitch. Thus, the NTSB concludes that, given that the FO was the PF and had not verbalized any problem to the captain or initiated a positive transfer of airplane control, the manual forward elevator control column inputs that were applied seconds after the inadvertent activation of the go-around mode were likely made by the FO. Further, the captain was communicating with an air traffic controller at the time, consistent with his PM duties

Somatogravic Illusion

The human body uses three integrated systems to determine orientation and movement in space: vestibular (otolith organs in the inner ear that sense position), somatosensory (nerves in the skin, muscles, and joints that sense position based on gravity, feeling, and sound), and visual (eyes, which sense position based on sight) (FAA 2016, 17-6). The vestibular and somatosensory systems alone cannot distinguish between acceleration forces due to gravity and those resulting from maneuvering the airplane.

Thus, when visual cues are limited and an airplane rapidly accelerates or decelerates, a pilot may be susceptible to a somatogravic illusion (FAA 2016, 17-6). Somatogravic illusion is a form of spatial disorientation that results from a false sensation of pitch due to the inability of the otolith organs of the human inner ear to separate the gravitational and sustained linear acceleration components of the GIF vector (Young 2003 and Cheung 2004). Rapid acceleration in an airplane stimulates the otolith organs in the same way as tilting the head backward and may lead a pilot to mistakenly believe that the airplane has transitioned to a nose-up attitude (FAA 2016, 17-7).49 The accident airplane was likely flying in IMC when the go-around mode was activated. The timing of the FO's subsequent nose-down control inputs correlated with increases in the airplane's longitudinal acceleration associated with the go-around mode-commanded an increase in engine thrust and retraction of the speedbrakes. This relationship suggests that the FO experienced a pitch-up somatogravic illusion at that time. Somatogravic illusion has long been recognized as a significant hazard that is likely to occur under conditions of sustained linear acceleration when outside visual references are obscured (Buley and Spelina 1970, 553-6). Further, such conditions can degrade a pilot's ability to effectively scan and interpret the information presented on primary flight displays. For a pilot flying in IMC with no external visual horizon, maintaining spatial orientation when presented with conflicting vestibular cues depends upon trusting the airplane's instruments and disregarding the sensory perceptions (FAA 2003, 8). However, for some pilots (particularly those who are not proficient with maintaining airplane control while referencing only instruments), the introduction of misleading vestibular cues can be compelling enough that the pilot may find it difficult to accurately assess or believe reliable sources of information about airplane attitude, such as the airplane's instruments. Thus, the NTSB concludes that the FO likely experienced a pitch-up somatogravic illusion as the airplane accelerated due to the inadvertent activation of the go-around mode, which prompted him to push forward on the elevator control column. After the FO began pushing forward on the control column and the airplane's pitch dropped below the horizon, its vertical acceleration rapidly decreased. Due to this change and the airplane's continued longitudinal acceleration, the resultant GIF vector sensed by the pilots swung dramatically aft. This likely exacerbated the FO's pitch-up sensation and possibly produced a sensation of tumbling backward, known as the inversion illusion (Cheung 2004). The FO's comments "oh" and "whoa," which expressed surprise, likely reflected his experience of one or both phenomena. 2.3.1.2 Other Factors Adversely Affecting Performance Surprising events in the cockpit increase task demands on a pilot to resolve them (Lazarus and Folkman 1984). These types of events can also cause acute stress, which involves perceiving an immediate danger, and can trigger a "fight or flight" response (FAA 2016, 17-12). The effectsof both surprise and stress can increase a pilot's perceived need to act while degrading the pilot's ability to accurately assess what needs to be done; this can result in impulsive and incorrect actions due to a physiological reaction known as a "startle response" (Landman et al 2017, 1161-72). About the time the FO expressed surprise, he rapidly brought the control column to an almost neutral position, then pushed it forward again. This action could have constituted intentional testing behavior to see how relaxing forward pressure on the column affected sensations of motion, or it could have occurred reflexively as a result of a startle response. About this time, the combined effects of the changes in the airplane's motion resulted in changes to the GIF vector similar to what would occur if the airplane were descending vertically in a near-level pitch attitude, which likely produced a sensation of falling. About this time, the FO exclaimed, "where's my speed" and "we're stalling," and continued to push the control column forward, exacerbating the airplane's dive. Although the FO declared that the airplane was stalling, the NTSB's airplane performance study found that the airplane's airspeed and wing AOA were not consistent with the airplane having been at or near a nose-high stalled condition. Further, the FO's response to excessively lower the nose of the airplane was contrary to standard procedures and training for responding to a stall, which prescribed first assessing the readily identifiable cues indicative of the airplane approaching an impending stall and disconnecting the automation. No such cues—such as stick shaker activation, stall warning annunciations, nose-high pitch indications (including those provided by the ADI's airplane attitude presentation and pitch limit indicator), and low airspeed indications-were present. The NTSB's investigation found no evidence that any of the sources of airspeed and airplane pitch information available to the FO were malfunctioning; thus, the FO's comments about airspeed and stall indicate that he was not effectively scanning his instruments and interpreting the information they provided. The FO's attention appears to have been fully absorbed by the incorrect sensations of pitching up and falling, which, for him, were the most compelling cues in his environment, leading him to incorrectly conclude that the airplane was stalling. This would have reinforced his perceived need to continue nose-down control inputs. The effects of sensory illusions, stress, and the startle response can adversely affect the performance of any pilot, and pilot training program and proficiency check requirements for Part 121 air carriers include emergency procedures scenarios intended to help a pilot develop and maintain the skills to appropriately assess and respond to a variety of stressful, startling scenarios. However, the accident FO had a history of training performance deficiencies in which he performed poorly in response to unexpected stressful events. Various instructors and check airmen from throughout the FO's career described training scenarios in which the FO demonstrated low situational awareness, became overwhelmed, overcontrolled the airplane, made numerous mistakes, and responded impulsively with inappropriate actions.

Based on the FO's history of training performance deficiencies, the FO was susceptible to responding impulsively and inappropriately when faced with a stressful, unexpected event. Therefore, the NTSB concludes that, although compelling sensory illusions, stress, and startle response can adversely affect the performance of any pilot, the FO had fundamental weaknesses in his flying aptitude and stress response that further degraded his ability to accurately assess the airplane's state and respond with appropriate procedures after the inadvertent activation of the goaround mode.

Captain's Delayed Awareness and Ineffective Response

Like the FO, the captain had been expecting the airplane to automatically increase thrust and slightly increase pitch to level off at the MCP-selected altitude of 3,000 ft msl. The captain, as PM, was required to actively monitor the flight, including the airplane flightpath, automation status, and the FO's actions as PF. Effective monitoring and crosschecking are essential because detecting an error or unsafe situation can be the last line of defense to prevent an accident (FAA

2004, 14). Based on the available CVR information, from before activation of the go-around mode until about 10 seconds after, the captain was setting up the approach to IAH on the FMC and communicating with ATC. While setting up the approach, the captain was likely head-down and concentrating on the FMC rather than monitoring the flight instruments or the FO's actions. This would reduce the captain's awareness of the airplane's automation status and energy state and could explain why the captain did not notice the "GA" indications on the flight mode annunciator or the EICAS or that the anticipated increase in airplane thrust began when the airplane was at a much higher-than-expected altitude. However, the captain's response to less subtle aspects of the developing situation, such as the FO's nose-down control column inputs associated with his spatial disorientation, were also delayed. Research has shown that a PM may be slow to take control when the PF is subtly incapacitated (for example, due to spatial disorientation) because the PM's recognition of something being wrong can be delayed if his or her attention is focused on normal operational tasks or if the deviation in performance is a surprise (Harper, Kidera, and Cullen 1971). As previously mentioned, at 1238:44, the FO said, "oh," indicating surprise, which was about 2 seconds after the captain's last routine radio communication to the controller and concurrent with the controller's response. It also occurred about 4 seconds after the cockpit's owl beeper sounded, which, based on the FDR data, likely indicated an autopilot caution alert (due to the opposing manual inputs on the control columns). At 1238:46 (about 15 seconds after the inadvertent activation of the go-around mode), the captain took hold of the left control column and started pulling back, countering the FO's continued nose-down control inputs. The NTSB concludes that, while the captain was setting up the approach and communicating with ATC, his attention was diverted from monitoring the airplane's state and verifying that the flight was proceeding as planned, which delayed his recognition of and response to the FO's unexpected actions that placed the airplane in a dive. About the time that the captain took hold of the left control column and started pulling back, the thrust levers were abruptly reduced then advanced; however, it is unknown which crewmember took this action. The captain's action on the control column was not followed by the command "I have control" to indicate a positive transfer of control of the airplane, as required by Atlas procedures. As a result, the captain and the FO each continued to apply opposing forces on the elevator control columns, with the captain adding enough force to overcome the elevator system's control column override mechanism and split the positions of the elevators on each side. The captain's and the FO's opposing elevator control forces continued for about 10 seconds, during which the airplane's dive continued to steepen. Thus, the NTSB concludes that the captain's failure to command a positive transfer of control of the airplane as soon as he attempted to intervene on the controls enabled the FO to continue to force the airplane into a steepening dive. Although the captain may have been trying to diagnose the situation and determine what corrective actions were needed, he likely experienced startle and surprise once he recognized that the airplane was in a dive, resulting in increased stress and reduced performance. Also, the situation was likely difficult for the captain to evaluate, considering that the FO's control inputs, the automated inputs, and external forces were each affecting control feel and airplane behavior. Although the captain asked the FO what was happening, the FO made only panicked statements and was unable to provide the captain with any useful information. The captain was being subjected to the same stressful and disorienting accelerations as the FO, which could have degraded his ability to correctly interpret the instruments and identify the most appropriate course of action. When such situations occur unexpectedly, they can be ambiguous and confusing. The captain's failure to disconnect the autopilot or autothrottle, in keeping with Atlas' procedures, during any point in the accident sequence suggests that he had not fully processed the airplane's energy state, automation status, or the reason for the FO's actions. Analysis of the available weather information determined that, once the airplane had descended through an altitude of about 3,000 ft msl (which corresponded with the expected cloud base heights for the area), it would have been exiting IMC; thus, the crew would have been able to clearly see the airplane's attitude and descending trajectory. About this time, both elevators began to move concurrently to an airplane nose-up position, attaining the full airplane nose-up position and remaining there until the end of the FDR recording. Thus, it likely that both the FO and the captain were pulling back on the control columns to arrest the airplane's descent, but, by this time, the situation was unrecoverable. Therefore, the NTSB concludes that the captain's degraded performance, which included his failure to assume positive control of the airplane and effectively arrest the airplane's descent, resulted from the ambiguity, high stress, and short time frame of the situation. FTP

Summer Health Check

Heat Illnesses

We know better than most just how hot summers can be. When it's scorching outside, we switch on the air conditioners, keep our water chilled with ice, and wear comfortable clothes. But when the mercury soars to extreme levels, we can get more than just hot and sweaty – heatwaves can put our health in danger.

As heatwaves are projected to last longer and occur more often, extreme heat could put more people at risk of harm. It's important to know how to care for our health when we're faced with extreme heat.

What is heat-related illness and what causes it?

Heat-related illnesses include heat cramps, heat exhaustion and heat stroke. These conditions can occur when we are exposed to extreme heat and our body can no longer cool itself or function effectively.

So how does it happen?

Our body's natural defence against overheating is sweating. Sweat evaporates from our skin and helps to cool us down. But in some situations, our body can't sweat enough to stay cool, or sweating alone won't combat the conditions we're facing. When our body temperature rises to dangerous levels, it can be fatal.

Some of the factors that contribute to heat-related illness include:

- Heatwaves – three or more days of high maximum and minimum temperatures that are unusual for the location or the time of the year
- Overexercising, particularly in hot conditions
- Wearing heavy, tight clothing in hot environments
- Lack of airflow, confined spaces, and crowded conditions, such as concerts and sporting events
- Exposure to radiant heat from bushfires
- Being in a parked car, particularly in hot conditions.

Heat-related illness can affect anyone, but those at greatest risk include:

- Older people, particularly the frail and those living alone
- Babies and young children
- People with existing medical conditions, such as heart disease
- People on certain medications, especially fluid tablets
- People on fluid-restricted diets

Symptoms and treatment for heat-related conditions

If you recognise the signs and symptoms of any heat-related illness, it's important to take action. Spotting the signs early helps to lower the risk of heat stroke, a condition that can cause permanent organ damage and potentially death, if untreated.

Anyone with a heart condition, diabetes, kidney disease, high blood pressure, or following a low sodium or fluid-restricted diet should seek medical help right away if symptoms of heat-related illness are present.

De-Hyderation

We often talk about dehydration in relation to the elderly, children and babies, or during extreme heatwaves. But the reality is dehydration can affect anyone at any time of year. Understanding what dehydration is, knowing if you are dehydrated and how to treat and prevent dehydration are critical to staying safe in the summer.

What is dehydration?

Dehydration happens when the body loses too much water. Your body loses water by sweating, going to the toilet and by breathing out tiny water particles when you exhale. Vomiting and diarrhoea can also see the body lose larger amounts of water.

Normally, you're easily able to replace this water by drinking more and by ingesting it in food. Dehydration happens when water is not replaced quickly enough to make up for water that is lost.

How can dehydration happen?

It can be surprisingly easy to become dehydrated. If you don't rehydrate regularly, you could become dehydrated if you:

- do exercise that is strenuous, prolonged or makes you very sweaty
- do manual work or work in a hot environment
- spend time in a hot or poorly ventilated indoor environment, like a heated gym or hot warehouse
- spend time in a dry environment, like a long-haul plane flight
- or spend time without access to water.
- Dehydration can also occur in windy environments, which allow sweat to evaporate more quickly.

Of course, doing any of these activities on a hot day will see you getting even hotter and sweatier. But it's also important to pay attention to rehydration during cooler months, when you might not feel like drinking enough water and heated air can dry your skin.

You can also become dehydrated from drinking alcohol or drinks that have caffeine in them, both of which act as a diuretic. This means that they make you go to the toilet more often, losing more water than normal

How do I know if I am dehydrated?

If you are mildly dehydrated, you might experience one or more of these symptoms:

- thirstiness

- a dry mouth, lips and tongue
- headache
- have urine that is a darker yellow than usual, and less of it
- light-headedness or dizziness.

If you are severely dehydrated, you might experience one or more of these symptoms:

- extreme thirstiness
- have a very dry mouth, lips and tongue
- crankiness
- drowsiness
- feel like you are breathing very quickly
- have a fast heart rate
- fainting
- have very little or no urine.

If you weigh more than one kilogram less after exercising or working, you are likely to be dehydrated.

What happens if I don't treat dehydration?

Not treating dehydration can have serious, even deadly, consequences. Your body is made up of approximately 50 – 75 per cent water and not having enough of it affects a large number of bodily functions. Dehydration can lead to other heat related illnesses like heat exhaustion and heat stroke, which can occur rapidly and can be fatal.

How to treat mild dehydration

For mild dehydration, the best thing you can do is drink water to rehydrate. Drink small amounts of water regularly. You can purchase oral rehydration solutions at the pharmacy which will also help replace electrolytes. Avoid drinking alcohol or caffeinated drinks.

How to treat severe dehydration

If you, or someone you are caring for, is severely dehydrated, you need to seek medical treatment immediately.

Call a doctor if you, or a person you are caring for, is feeling very unwell or displaying signs of heat stroke.

How to prevent dehydration

You can follow these steps every day to help prevent dehydration:

- drink plain water often
- always carry water with you when you leave the house – use a BPA-free or stainless steel container
- seek cool or shady places when you are out of the house
- be mindful of dehydration when doing outdoor activities
- take extra care on really hot days.

How much water should you drink?

Try to drink enough water every day, even if it isn't hot or you aren't doing a lot of exercise. Men should drink 2.6 litres or ten cups of fluid each day. Women should drink 2.1litres or 8 cups of fluid each day. If you are exercising, sweating a lot or are in a hot environment, you will need to drink extra water to make up for the water you are losing.

If you have questions about how much fluid you should drink, or if you have any medical conditions or are taking any medications that might change your fluid requirements, talk to your doctor about how much fluid you need.

Sports drinks that contain electrolytes are not necessary for rehydration under usual circumstances. These drinks can be used to rehydrate if you have exercised continuously for 90 minutes or more. If in doubt, drink water instead.

As you start a new water drinking habit, you might also want to reconsider your regular drinking habits and rethink sugary drinks.

Can I drink too much water?

Excessive water intake can cause a rare condition called hyponatraemia. Hyponatraemia happens when very large quantities of plain water are drunk and affects the level of salt in the blood.

If you are dehydrated, drink small amounts of water regularly to give your body time to process it, rather than drinking a lot of fluid in a short space of time. FIP

Source: Website of Queensland Health. (www.health.qld.gov.au), Minor edits for Indian Readers

Gusty Winds Cause a Tail Strike in London

The aircraft was on a scheduled flight from London Heathrow Airport to Perth Airport in Australia. Following a normal engine start and taxi, the aircraft was cleared for takeoff from Runway 27R with the surface wind reported as 220° at 28 kt gusting 44 kt. Acceleration was normal in the strong wind and, at VR of 172 KIAS, the PF initiated a rotation which was coincident with a strong gust. Shortly after becoming airborne, the EICAS tail strike message was displayed. The crew elected to hold to the southwest of Heathrow at 6,000 ft whilst they carried out relevant actions from the Quick Reference Handbook (QRH), which prevented aircraft pressurisation and prepared to return to Heathrow. The aircraft was then radar-vectored for an approach to Runway 27L at Heathrow, where an overweight landing was made.

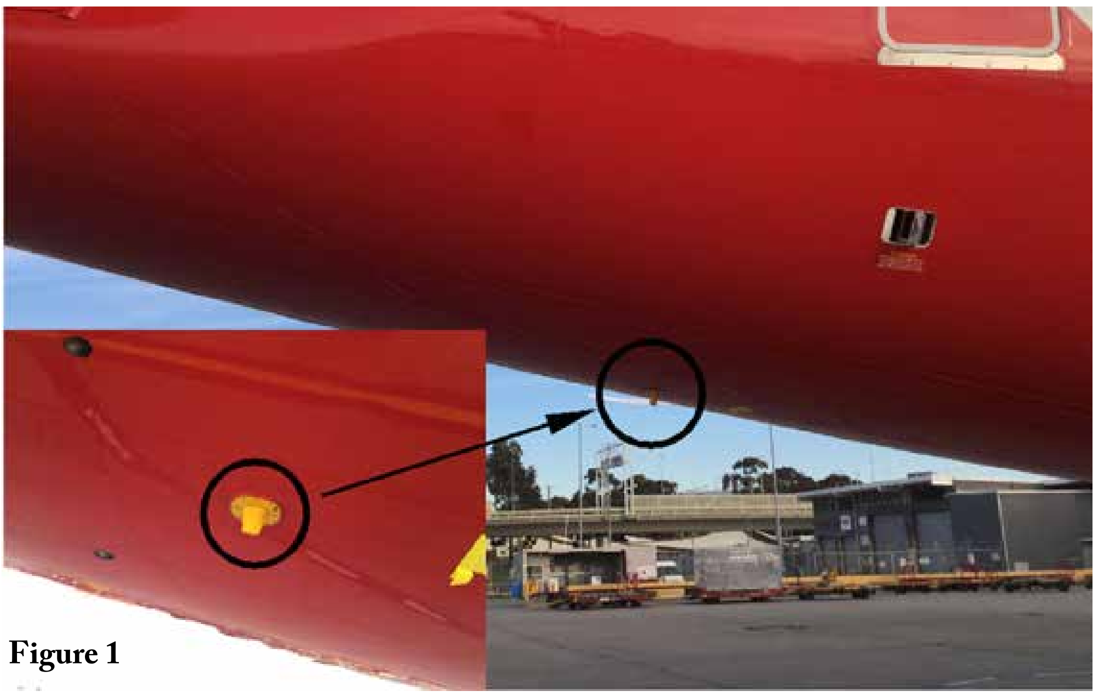


Figure 1

Tail Strike Protection System

The Boeing 787 is fitted with a tail strike protection system that automatically adjusts the position of the elevators so as to reduce the potential for tail contact with the ground during takeoff and landing. The system does not degrade takeoff performance. Tail strike detection and alerting system Tail strike detection is provided by a 2" blade sensor fitted to the rear lower fuselage of the aircraft (Figure 1). If the electrical circuit within the sensor is compromised due to contact with the ground, a tail strike caution message is displayed on EICAS after five seconds. This is accompanied by an aural warning and master caution light being presented in the cockpit.

Recorded Information

Flight data was available from the aircraft's Continuous Parameter Logging (CPL)1 system and FDR. Parameters included the aircraft's airspeed, the position of its wing spoilers, cockpit control columns and wheels, and pitch rate and tail height (which indicated the distance between the tail strike detection sensor and the ground). The aircraft manufacturer advised that due to factors including aircraft loading and runway slope, the tail height parameter may not always reach zero when the aircraft tail contacts the ground. The aircraft was correctly configured for takeoff, with the flaps set to five, and VR was 172 kt. The data showed that during the takeoff run, there were airspeed fluctuations consistent with the gusty wind conditions. Upon reaching an airspeed of 160 KIAS, the airspeed rapidly increased to 175 KIAS, at which point the PF initiated the rotate (Figure 3 - Point A)

As the aircraft pitched up, the airspeed reduced to 172 KIAS, where it briefly stagnated (Figure 3 - Point B). The PF had progressively moved the control column aft to 4° (Figure 3 - Point C)

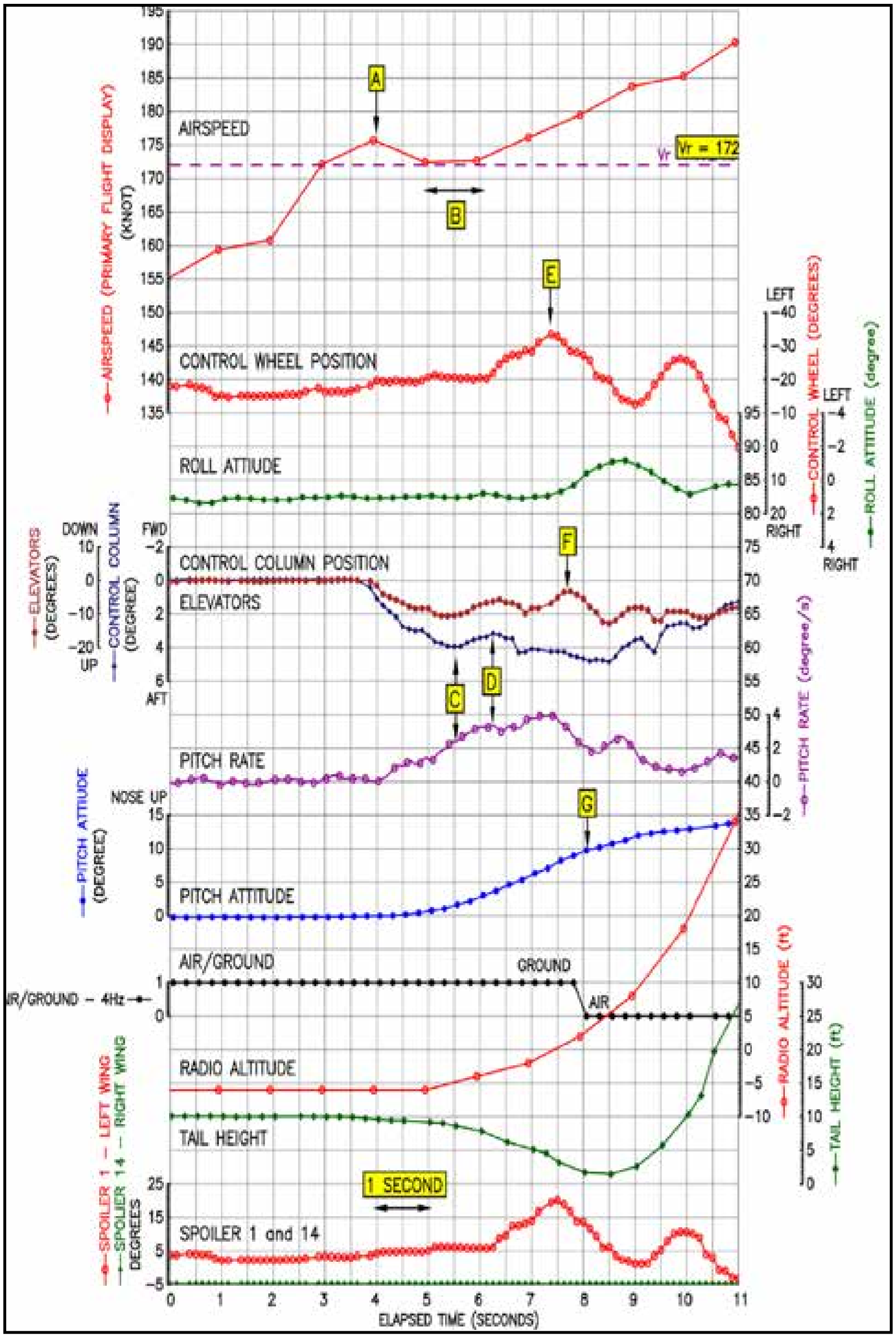


Figure 3

Salient flight data parameters

at which point the pitch rate was just over 2°/s; the maximum aft movement of the control column was 9.8°. The control column was then moved slightly forward (Figure 4 - Point D) to 3°, but the pitch rate increased to 3.2°/s. The airspeed then started to increase, which coincided with the PF pulling back on the control column whilst also moving the control wheel from 20° counter-clockwise (CC) to 33° CC (Figure 3 - Point E). This caused the left spoilers to further deploy from 5° to 20°

As the pitch attitude increased through 6.3° nose-up, the pitch rate was nearly 4°/s, and the calculated tail height above the runway was 4.5 ft. The aircraft's tail strike prevention system then started to move the elevators (Figure 3 - Point F), which reduced the pitch rate to just over 2°/s. The pitch attitude at takeoff was about 9.7° (Figure 3 - Point G) and the tail height indicated just less than 2 ft.

The aircraft manufacturer analysed the FDR and CPL data and stated: 'The near tail contact was the result of a combination of factors including: high pitch rate close to lift-off, airspeed stagnation, and control wheel usage deploying spoilers on the left wing. The high pitch rate allowed pitch attitude to increase towards the tail contact attitude prior to airspeed reaching lift-off speed. The deployed spoilers on the left wing decreased lift and necessitated a higher pitch attitude for lift-off.'

Analysis

The aircraft was being operated within its weight, CG and wind limitations for the takeoff. The weather conditions created strong gusting winds which, just before the point of rotation, rapidly increased the aircraft's airspeed from 160 KIAS to 175 KIAS. The initial pitch rate of 2°/s increased to 3.2°/s and then 4°/s, when the tail strike prevention system activated and reduced the pitch rate to 2°/s. The lateral control wheel inputs caused the left spoilers to deploy from 5° to 20°, decreasing the lift. The combined effect was that during rotation, an increase in aircraft pitch angle with the main landing gear wheels still on the runway, led to the tail contact angle of 9.7° being reached and the crew receiving an EICAS tail strike message. Having been alerted to the tail contact by the EICAS message, the flight crew actioned the QRH and prevented the aircraft pressurising. After holding, the aircraft was flown to Heathrow in accordance with the checklist

Aviation & Sustainability

ICAO Goals for Fuel Burn & Emissions

At the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) 10th Meeting in Montreal, Canada, on February 2016, it was agreed that a process led by Independent Experts (IEs) would be used to conduct an integrated technology goals assessment and review.

The Independent Expert panel was tasked with providing goals for fuel burn, noise, and emissions in the mid-term (2027) and the long-term (2037). The panel was also asked to consider the interdependencies among changes to fuel burn, noise, and emissions. During the independent experts modelling process, it was only possible to consider interdependency between fuel burn and noise. In considering and optimizing for fuel burn, the independent experts used the fuel-burn metric (mass of fuel burned per payload-tonne-kilometre, kg/ATK), but for the final recommended goals, these were converted to be in terms of the CO2 metric value. The optimization for noise used the cumulative noise (in EPNdB) of the three certification points (side-line, fly-over and approach). The IEs considered four classes of aircraft: business jets (BJ), regional jets (RJ), single-aisle aircraft (SA) and twin-aisle (TA). To establish fuel burn, emissions, and noise baselines, reference aircraft were modelled which were chosen to represent the four major in-service categories. Originally, the plan was to use generic (i.e. hypothetical) Technology Reference Aircraft (TRA), which are representative of aircraft in service in 2017, so as to avoid competitive issues. However, to ensure the availability and consistency of input data, the most recently certified aircraft fitting as closely as possible into each class were used as notional references, and these aircraft are listed in Table 1.

TABLE 1: Technology Reference Aircraft Types and Related Operational Aircraft

Aircraft Class	Number of Seats	Notional Aircraft
Business Jet (BJ)	<20	Gulfstream G650ER
Regional Jet (RJ)	20-100	Embraer E190-E2
Single Aisle (SA)	101-210	Airbus A320neo
Twin Aisle (TA)	211-300	Airbus A350-900

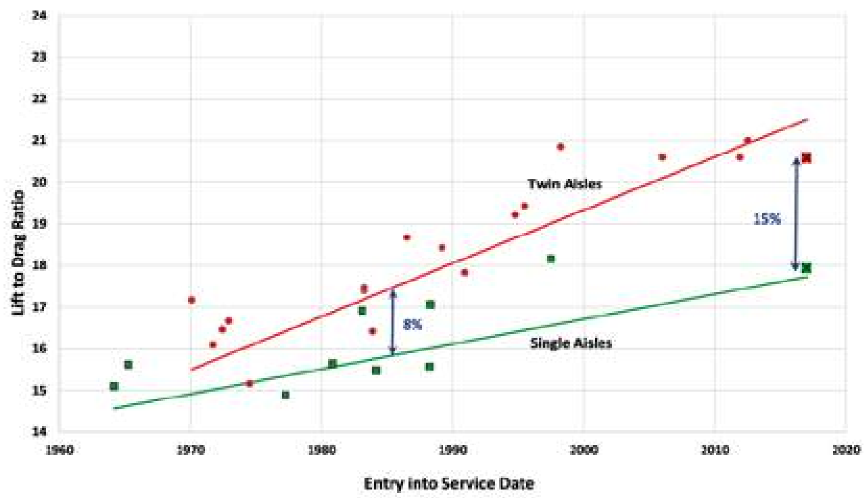
Attention was concentrated on the Single-aisle (SA) and the Twin-aisle (TA) aircraft, which overwhelmingly have the largest environmental impact. It became apparent during the review that the division between RJ and single-aisle aircraft was blurred. The Embraer E190- E2, used for this review, and the Airbus A220 (formerly Bombardier C-series) both carry more than 100 passengers although they are notionally classed as regional jets. Likewise, a large business jet (BJ), like the G650ER, is comparable in size to some smaller RJs, though it is very different in terms of mission.

The counter-rotating open-rotor (CROR) was discussed, but it was considered to have a low probability of being ready for service by 2037 and was not therefore modelled in this review.

Aviation Environmental Impact Overview

For climate change, the primary concerns are emissions of Carbon dioxide (CO_2), Nitrogen oxides (NO_x) and non-volatile particulate matter (nvPM). Also of concern are persistent contrails which lead to cirrus clouds when the atmosphere is icesupersaturated. A significant complication arises because the emissions (or their subsequent transformations) have quite different residence times in the atmosphere. They also have quite different values of radiative forcing, which is a measure of the associated heating or cooling effect. It is the combination of a number of factors which determine overall impact on global surface temperature over a given timescale. These factors are: quantities emitted, residence time, radiative forcing, and the temperature response profile of a particular pollutant. CO2 is of particular concern because of its exceptionally long residence time (thousands of years). The radiative forcing value for aircraft NOx per unit emission is now thought to be lower than the two previous Independent Expert NOx reviews, but it remains of concern. Although nvPM is implicated in cloud formation, the processes are less well understood. Contrails, leading to cirrus clouds and aircraft induced cloudiness, have large Radiative Forcing (RF) impacts but are short lived (hours). There is high confidence in the estimates of global warming due to CO2 whereas for all other emissions there is a significant level of uncertainty which needs to be reduced.

FIGURE 1: Historical Trend in Lift-to-Drag Ratio

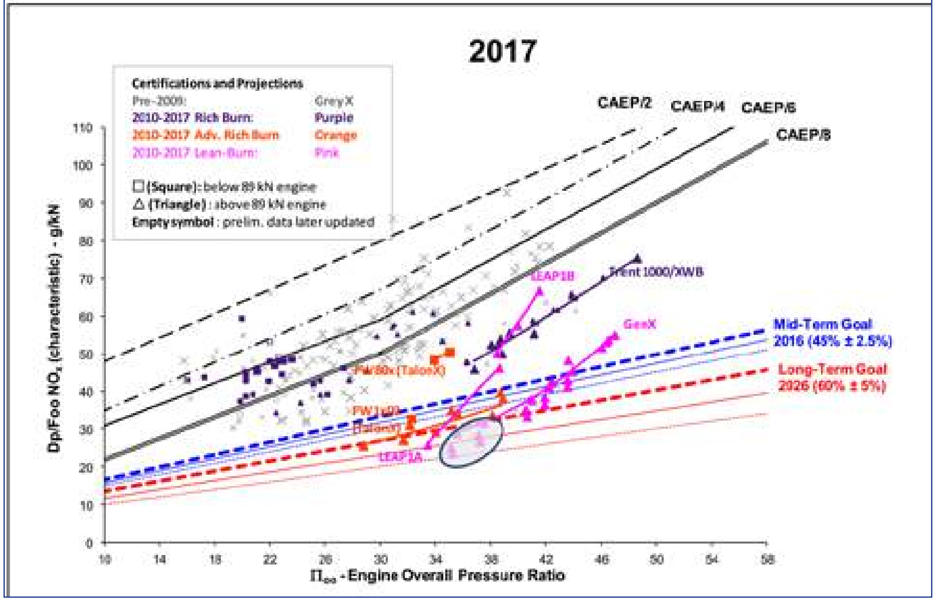


Technology Based Reduction Potential

Fuel burn is considered here for the two aircraft classes that burn the largest proportion of fuel, the single-aisle and twin-aisle. The discussion is separated into airframe and engines, with the airframe section itself being divided into aerodynamics and mass (often referred to as weight).

Airframe: A useful measure of aerodynamic performance of an aircraft is the lift-drag ratio, L/D. Historical data for L/D is shown in Figure 1 where trend lines have been drawn through the values for the single-aisle and TA. The L/D ratio is higher for longrange twin-aisle aircraft than for the shorter-range single-aisle aircraft. In both cases, the L/D has increased with time, but the average rate of improvement for the twin-aisle is about twice that for the SA. An important piece of information relating to the difference between the two aircraft sizes comes from the mid-1980s, when both Airbus and Boeing were building single-aisle and twin-aisle aircraft; because this was going on at the same time the technology level of the two aircraft classes was broadly the same. At that time, L/D was about 8% higher for the TA, and this difference is believed to be mainly because of different design and missions for the single-aisle and TA, each with the same level of technology. The IEs had the technology reference aircraft listed in Table 1 for 2017. The L/D for the twin-aisle in this case is about 15% higher than the SA, implying a relative slippage of about 7%. As Figure 1 shows, the aerodynamic performance of the airframe (characterized by lift/drag ratio) for a single-aisle aircraft, such as B737 and A320, has improved over the past four decades by approximately half as much as the larger twin-aisle aircraft. A significant part of this difference is believed to be because the B737 and A320 have their origins far in the past, with improvements in their airframe technology being incremental. Incremental change does not allow the gains possible for an all-new aircraft from a full basket of new technologies. The aerodynamic performance can be improved by the use of laminar flow: natural laminar flow for smaller aircraft, which usually fly slower and have less sweep, and hybrid laminar flow (requiring suction) for the twin-aisle aircraft. The use of laminar flow technology on wings has primarily been held back due to manufacturing and operational considerations and challenges. Evidence provided by the International Coordinating Council of Aerospace Industries Associations (ICCAIA) suggests that reasonable goals for aircraft aerodynamics, adopting a basket of technologies, including laminar flow, are between 3% and 4% total draft reduction for single-aisle and twin-aisle aircraft by 2027 and between 8% and 10% by 2037. Based on the slower rate of historical improvement for the single aisle, the IE review panel have assumed that a wholly new airframe for the single-aisle size of aircraft will be able to improve the aircraft aerodynamic performance over and above the incremental improvements quoted by ICCAIA. In modelling the performance of the single-aisle aircraft, it was therefore assumed that there would be all-new airframes for this class by 2037. Based on this evidence, the total drag for the single-aisle aircraft was lowered by an additional 3% by 2027 and 7% by 2037, beyond the reduction from the new technologies presented by ICCAIA. There is now some evidence that the values of L/D for the twin-aisle aircraft may be approaching an asymptote (the value depending on materials properties and cost, as well as aerodynamic design). To get further significant improvements in L/D for the twin-aisle aircraft may require a switch to a non-conventional configuration (i.e. other than tube and wing) or to exploit the benefits of composites to increase wing span requiring increase to airport gate widths. Reducing aircraft empty mass is vital. Improved metals and metal

FIGURE 2: LTO NOx Levels as a Function of OPR. Points Refer to Engine Certification Levels

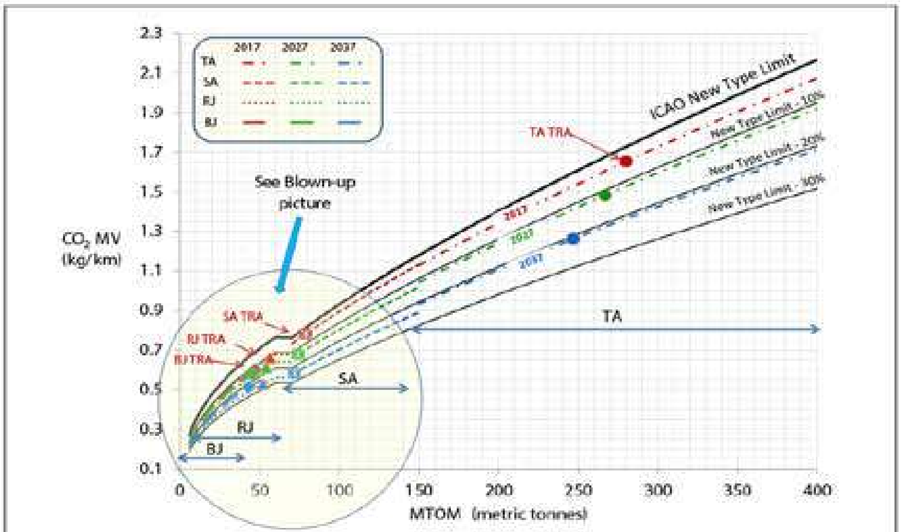


construction is available, but the use of composites is generally favored for structural components for all new designs. From information provided by ICCAIA, potential overall mass savings with metal are in the range 5±2%. With advanced composites, possible savings of 8±2% for the single-aisle and 4±2% for the twin-aisle aircraft. There are other mass reduction technologies under consideration that could yield savings around 2.5% for small aircraft and 4% for large. Overall, for the purpose of setting fuel burn goals, the empty mass savings are in the range 2-4% for 2027 and 8-10% for 2037.

Engines

For engines, the overall efficiency is conveniently separated into propulsive efficiency, which depends only on the fan pressure ratio (FPR), and the thermal efficiency, which depends on the overall pressure ratio (OPR) and the turbine entry temperature. In addition, there is a strong dependence of overall engine efficiency on the component efficiencies of the fan, compression system, and turbines. OPR itself is limited by compressor delivery temperature at take-off and is unlikely to exceed 60. Turbine entry temperature is limited by available materials and airfoil cooling technology but is unlikely to increase significantly from the best current values since increased cooling air requirements reduce efficiency. Further improvements in thermal efficiency will require a combined approach, including incremental increases in OPR and turbine entry temperature, coupled with a continued increase in compressor and turbine efficiencies. Increasing, or even maintaining, compressor and turbine efficiencies becomes more important, but also more difficult, as OPR rises because of the reduction in core size. Fan pressure ratio has been reduced in recent years to yield significant reductions in fuel burn and noise. As FPR is reduced, the diameter of the fan must increase to produce the same thrust. With the increase in diameter comes an increase in power plant mass

FIGURE 8: CO_2MV versus MTOM and Percentage Reductions from the "New Types" Level



Points show Optimization for Nominal Confidence at the 50% fuel-burn/50% noise weighting, Performed at R_1 for 2017 TRA.

and drag, as well as growing issues with power plant-airframe integration. The larger diameter fan rotates more slowly and therefore makes the design of the low-pressure turbine (LPT) more difficult. Some amelioration of the integration issues comes with the insertion of a gearbox between the fan and the LP turbine. The selection of optimum FPR therefore requires the integration issues to be taken into account, particularly the increased drag and mass. For 2027, the potential fuel burn reductions attributable to the new propulsion technologies have been preliminarily estimated to be about 5% for single-aisle and about 6% for twin-aisle aircraft. For 2037, an extra 5% fuel burn reduction might be obtained. These numbers include gains in the propulsive efficiency, mass and drag, derived from all new propulsion technologies. These estimates exclude benefits from possible new nacelle technologies and improved propulsion system/airframe integration for which no information was available

Engine Emissions: Status and Reduction

Emissions from combustion of aviation fuel affect human health and welfare through degraded air quality as well as through climate change. Under all reasonable scenarios of technology change and aviation growth, total fleet fuel burn and the mass of NOx emissions are expected to continue to rise. Aircraft are unique in that they emit emissions that change air quality, both while on or near the ground and during cruise. At cruise altitudes, the emissions undergo chemical and physical transformations. The climate impact of NOx emissions is still thought to be significant relative to CO2, though less than in previous IE reviews. Some studies note that there is also the potential for aircraft emissions emitted at cruise altitudes to reduce surface air quality and affect human health. Historically, the focus has been on the landing and take-off (LTO) cycle, when aircraft are at their closest to populations around airports, with concentrations falling off rapidly with increasing distance from the airport. Nitrogen dioxide (NO2) from NOx emissions, and its photochemical derivative, ozone (O3), are identified as harmful to human health, though quantification of this is unreliable. More recently, attention has been directed at non-volatile particulate matter (nvPM), and of particular concern are ultrafine particles, less than 100 nano-metres, which is the particle size produced by aircraft combustors. Previously 'smoke' was a major concern, and standards are based on opacity measurements. In addition, NOx and oxides of sulfur (SOx) are precursors of secondary volatile PM formation, which takes place over considerable distances away from the source. The contributions to local concentrations of pollutants from LTO operations are higher than the contributions from cruise, but the numbers of people affected are relatively small. For emissions from higher altitudes, the increase in concentration at the surface is much smaller than for LTO but much larger numbers of people are potentially affected. The LTO levels of NOx plotted in the conventional way against engine OPR is depicted in Figure 2. Lines are shown for the certification levels and for the goals set by an earlier Independent Expert review. The current LTO based NOx goals set by Independent Experts for 2016 (mid-term) and 2026 (long-term) have both already been met. However, the engines which meet the goals are de-rated versions within an engine family. It should be noted that an engine operating at de-rated condition has poor fuel consumption and large weight in relation to thrust and would be uncompetitive. In most cases, higher power versions in the same family perform relatively poorly for emissions against the same LTO goals. A major cause is the increase in allowable turbine entry temperature used to promote higher engine efficiency and lower CO2 emission. The turbine entry temperatures are now reaching levels at which NOx formation becomes unavoidable and significant. At sufficiently high temperature, the NOx formation process is essentially independent of the technology to control the main combustion process itself, and is not dependent solely upon the OPR on which the current LTO goals and regulation for NOx are based. This results in a wide variation in performance of similar technology engines against the current LTO NOx metric. A new way to characterize NOx emissions needs to be found which accounts for the turbine entry temperature effect. This is of particular importance given the concern regarding NOx emitted at altitude. Looking at future NOx technology, the IEs believe that as a result of the turbine entry temperature increases, the NOx emissions from combustors with the best technology appear to be approaching an asymptotic value, with no step change envisaged during the goals timescale. In terms of goal setting, significant improvements in the best NOx levels set against the current LTO metric are not anticipated, although there are expected to be improvements in the general NOx levels across the range of engines. The IEs noted that full-flight NOx emissions per available seat kilometer across the fleet are not reducing significantly. The steps to reduce fuel burn, such as increasing OPR, have generally led to higher emissions of NOx which still meet the current LTO NOx standards and goals. The IEs propose the setting of a 2027 mid-term LTO-based NOx goal at the level of 54% below CAEP/8, which is 6% below the current 2026 goal-meeting level, with tightened criteria to be defined when the goal is met. The goal applies to all aircraft classes. The IEs recommend that CAEP consider carrying out urgent work to study two emission-related issues in particular. One is an assessment whether there is evidence of health impacts from aircraft-produced NOx both near the airport and at cruise. The other is the development of a method to allow a future review to set full-flight based NOx goals. On this basis, a goal for 2037 may be considered having in mind the interdependency with CO2 emissions and cost. The IEs were aware of the concerns regarding health impacts of nvPM, with increasing evidence of the harmfulness of ultrafine particles (smaller than 100 nm). It also appears that the particles emitted by aircraft engines are ultrafine, with the number of particles peaking at about 60 nm. Regulation is being considered for the much larger nvPM2.5 particles (2.5 mm which is 2500 nm). Fortunately, the new technologies directed at reducing NOx, which are currently entering service appear, initially, to offer an order of magnitude reduction in nvPM mass and number compared to most in-service engines. However, industry experts advise that early difficulties in service (making the combustors work stably and with adequate longevity) are likely to result in trade-offs between nvPM and NOx emissions at higher OPRs and turbine entry temperature. As a result, development issues with lean-burn and advanced rich-burn may not result in the full order of magnitude reduction in nvPM being achieved, though reductions are still expected to be substantial. Given the lack of data, the lack of technologies to reduce nvPM directly, and the prospective step reduction in nvPM emissions from recent combustors designed to reduce NOx, the IEs considered that the setting of nvPM goals at this time appears neither practical nor appropriate. Once technical data becomes available and climate and air quality impacts are better understood, there may be merit in setting goals for nvPM. FIP

TABLE 2: Fuel Burn Metric (FB/ATK) at Two Ranges for the Four TRAs in 2017.

	BJ	RJ	SA	TA
Design range	0.632	0.158	0.147	0.190
R_1 Range	0.343	0.146	0.125	0.126

TABLE 4: Current Fuel Burn Goals Compared to Prior Goals

Goals from 2010 IE Review

Year	SA	STA
2020	1.70%	1.43%
2030	1.38%	1.43%

Goals from Current Review

Year	BJ	RJ	SA	TA
2027	0.42%	0.77%	1.26%	1.04%
2037	0.71%	1.03%	1.22%	1.28%

This Article is based on the material from The ICAO Environmental Report 2019, Chapter One: Aviation and the Environment: Outlook By Prof. Nick Cumpsty (Imperial College, London), Prof. Dimitri Mavris (Georgia Tech University) and Dr. Michelle Kirby (Georgia Tech University)

FEDERATION OF INDIAN PILOTS

The Federation of Indian Pilots (FIP) was founded in 1996 to address various issues which affected pilots throughout the country.

To enhance the Professional Knowledge in the pilot community, the FIP has been hosting Flight Safety Seminars and professional workshops on a yearly basis.

As the FIP is Not a Trade Union, but a professional body managed by serving and retired aviators who bring with them a great deal of knowledge and technical expertise, it has been successful in taking up various Legislative Issues/ Safety issues with the concerned authorities.

Many Pilots lack a University Degree to reflect the professional knowledge they have acquired in their careers. To provide pilots with academic qualifications equivalent to their colleagues in other branches of aviation, the FIP founded the Institute of Aviation and Aviation Safety (IAAS).

Being declared Permanently Medically Unfit (PMU) invariably results in the cancellation of a Pilot's License. This causes great financial strain and could happen without warning at any stage in a pilot's career. To provide financial assistance to such pilots who have the misfortune to be declared Temporarily Medically Unfit (TMU)/Permanently Medically Unfit (PMU), the FIP started a unique scheme to insure a Pilot's Licence that provides a Loss of Licence and a Personal Accident Cover. This scheme has been running successfully since 1999 and has benefitted many of its members.

Keeping in mind the rising costs of medical treatments, the FIP in 2015 introduced a Group Medical Coverage (GMC) that was available to all its members and their dependents. Since then the managing committee has worked tirelessly to ensure that the policy provides the best possible coverage.The generous benefits of policy include reimbursement for air ambulance expenses, coverage of siblings, coverage of parents or parents in-law.

This policy has considerably benefited our members and their families as can be observed from the following figures of CY 2020-2021

In 2020-21 there were 1955 members who opted for the policy and a total of INR 14.16 Cr was paid out as claims.

On behalf of our Family of Pilots the Managing committee of FIP welcomes you!

FEDERATION OF INDIAN PILOTS

FIP

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Photograph

MEMBERSHIP FORM

1. SURNAME____________________ FIRST NAME____________________

2. LICENCE ATPL / ATPL (H) / CPL / CPL (H) NUMBER____________________

   VALIDITY____________________ DATE OF BIRTH__________ AGE__________

3. MAILING ADDRESS____

   ____

   CITY____________________ PINCODE____________________

   PHONE____________________ MOBILE____________________

   EMAIL____________________

4. COMPANY____________________ DESIGNATION____________________

5. ORDINARY MEMBER / ASSOCIATE MEMBER / CORPORATE MEMBER

________________ ____________________

D A T E SIGNATURE OF APPLICANT

(will be filled in by the FIP office)

MEMBERSHIP NUMBER____________________

VERIFIED BY____________________ SIGNATURE____________________

- ANNUAL MEMBERSHIP for Ordinary and Associate members is Rs **1,700/-**
- LIFE MEMBERSHIP for Ordinary and Associate members is Rs **17,000/-**
- Please send your cheque in favour of "FEDERATION OF INDIAN PILOTS" and write your name on the reverse of the cheque.
- Any Pilot holding an Indian Licence can become an ORDINARY MEMBER and has voting rights.
- Any individual interested in aviation can become an ASSOCIATE MEMBER but has no voting rights.
- Any company associated with aviation can become a CORPORATE MEMBER. (contact F.I.P. Office)

PROPOSAL FORM FOR LOSS OF LICENCE & PERSONAL ACCIDENT POLICY

Membership No.: O - ___________ Proposal No.: [ ] (To be filled by the FIP office)

I hereby apply as a bonafide member of the FIP for Loss of Licence & Personal Accident Policy as under:

Name: CAPT.____

Mailing Address: ____

____

Tel/Mobile Number: ____

Email Address: ____

Designation: (Tick √ in the box) Captain [ ] First Officer [ ]

Employer's Name: __________________ Employee/Staff No : __________________________

Employment Status: (Tick √ box)

Permanent Employee: [ ] Date of Retirement ____/____/_______(DD/MM/YYYY)

On Contract: [ ] Date of Expiry of Contract____/____/____(DD/MM/YYYY)

Date of Birth: ______/______/___________Age Completed _________________ (Years)

Date of last Medical __________________ Date of Next Medical: ______________________________

Type of Licence presently held & No____

Validity of Licence (DD/MM/YYY) :________________________________

Annual Salary as per last FY Form 16 INR: _____________________________

Present net monthly Salary INR : ___________ _______________________

Sum Insured INR: _____________________Bonus (If applicable. To filled by FIP Office)

Name of Nominee 1_________________ Relationship___________Percentage__________________

Name of Nominee 2_________________ Relationship___________Percentage__________________

Name of Nominee 3_________________ Relationship___________Percentage__________________

Cheque No: __________________ Dated: ___/___/___ For INR: ______________________________

Drawn on Bank:_________________Branch ____

(Note: Insurance is subject to realization of the Cheque).

I hereby declare I have not availed any other "Loss of License Insurance" cover, apart from:

i) **The cover I am purchasing by way of this proposal form**

A N D

ii) **Any such cover provided by my employer.**

I accept that this policy will cease to exist if any other "Loss of License Insurance" cover is found to exist in conjunction with either of the types of insurance cover(s) referred in paragraphs (i) and ii) above .

It is understood that a valid flying licence issued by the Directorate General of Civil Aviation (Govt. of India) and the possession of a valid medical certificate/assessment issued by the Competent Authority to exercise the privileges of the same licence, are the two criteria for the issue / renewal of this Loss of License Insurance cover.

I hereby declare I am not willfully suppressing any information regarding any condition, medical or otherwise, that presently debars me from holding a valid flying licence.

I warrant that the above statement and particulars are true and hereby agree that this declaration shall be held to be promisor and shall form the basis of contract between me and ICICI LOMBARD GENERAL INSURANCE COMPANY LTD and I am willing to accept a policy subject to the Terms and Conditions prescribed by the company as agreed to by the Federation of Indian Pilots

Further I undertake to submit the relevant / required documents as desired by ICICI LOMBARD GENERAL INSURANCE COMPANY LTD, in the event of any claim.

I declare that the particulars given by me are true to the best of my knowledge and I agree to accept that if any information furnished by me is false then my policy stands cancelled.

Place: ________Date: / /20 **Applicant / Proposer's Signature**

Institute of Aviation and Aviation Safety (IAAS)

(Education Wing of Federation of Indian Pilots)

A Professional Educational Institute affiliated to the University of Mumbai
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1. B.Sc (Aviation) Degree (University of Mumbai) along with issue of Commercial Pilots Licence
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2. B.Sc. (Aviation) Degree (University of Mumbai) for pilots holding CPL/ATPL Licences
* Duration of Course 2 Yrs.

3. Ground Studies for Commercial Pilots Licence Examination (held by DGCA)
* Subjects Air Regulations, Air Navigations, Meteorology and Aircraft & Engine (General and Specific)
* Duration of Ground Training Programme 12 Weeks.

4. Ground Studies for ATPL Examination (held by DGCA) Duration 12 weeks

5. Flying Training Programme along with Ground studies for the issue of Commercial Pilots Licence
* Duration of Course 12 months

For More information please conctact: Sachin Mob. +91 9619387273

Our Address :

Minimum eligbility for admission H.S.C. (10+2) with Physics and Maths

For detailed information, please contact

Lotus Corporate Park
12th Floor, C-Wing 1202, Jai Coach Signal,
Western Express Highway
Ram Mandir Fatak Road, Goregaon (East),Mumbai - 400 063
Nearest Railway Station, Jogeshwari (East)