AVIATION SAFETY

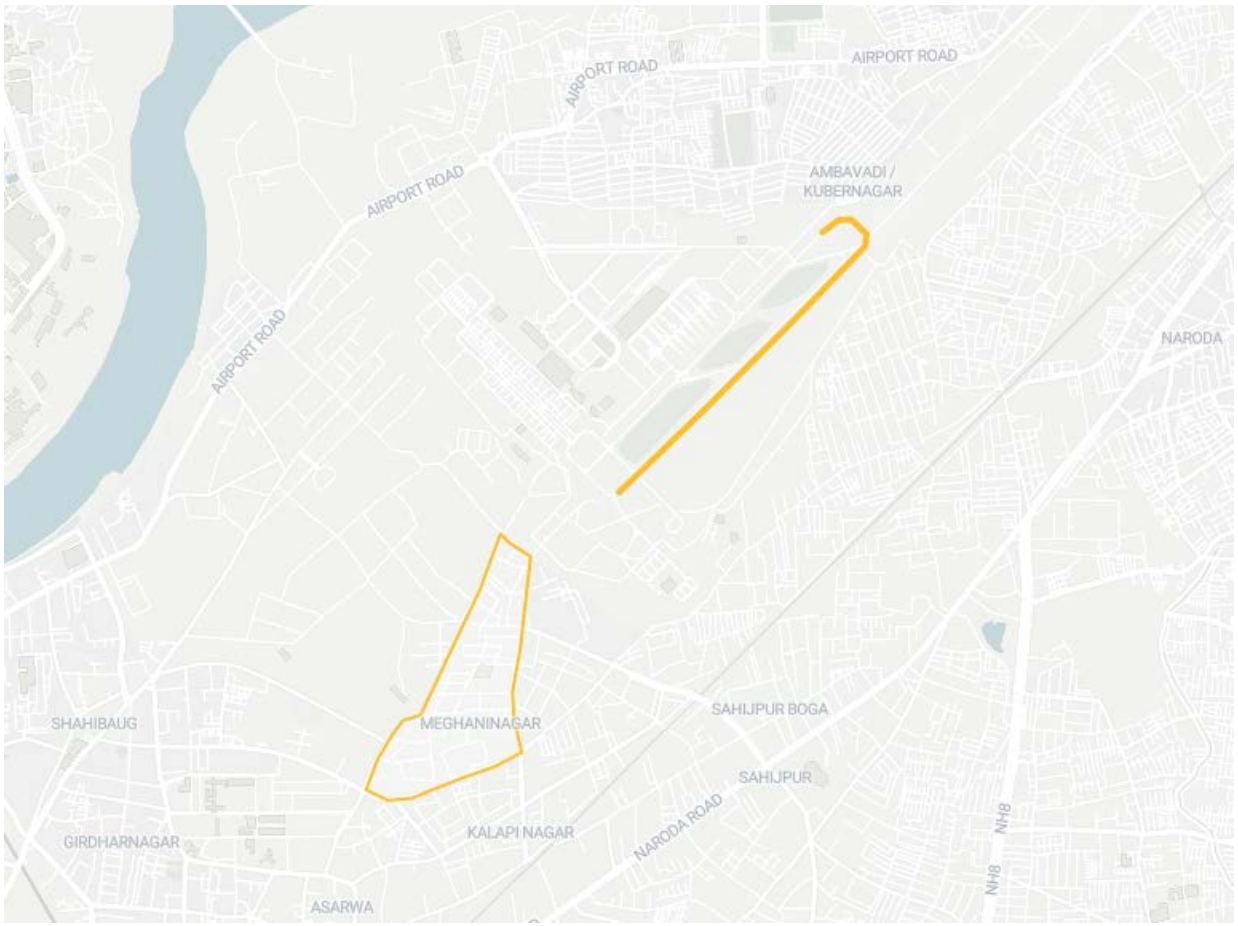
Role of Technology & Human Errors

Context:

- An **Air India Boeing 787 Dreamliner** plane with at **least 242 people** on board crashed on a medical college hostel close to an airport on the edge of **India's western city of Ahmedabad on June 12, 2025.**
- Air India confirmed later that **241 of the 242 people** on board had been **killed.**

1. Where and when did the plane crash?

- **Air India Flight AI171** was headed to **London Gatwick Airport** on **June 12, 2025** where it was **due to land at 6:25pm local time** (17:25 GMT).
- According to flight tracking website Flightradar24, the **plane's final signal was received seconds after takeoff at 1:38pm local time** (08:08 GMT).
- It had reached an altitude of 625 feet (190 metres) before **crashing back to the ground outside the airport,** close to densely populated residential areas on the outskirts of the city.



2. What do we know about the victims?

- Air India has confirmed that **241 of the 242 people on board were killed.**
- One British man survived.
- As per Air India there were **169 Indian nationals, 53 British nationals, 1 Canadian national and 7 Portuguese nationals**
- The airline described the incident as “a tragic accident”.

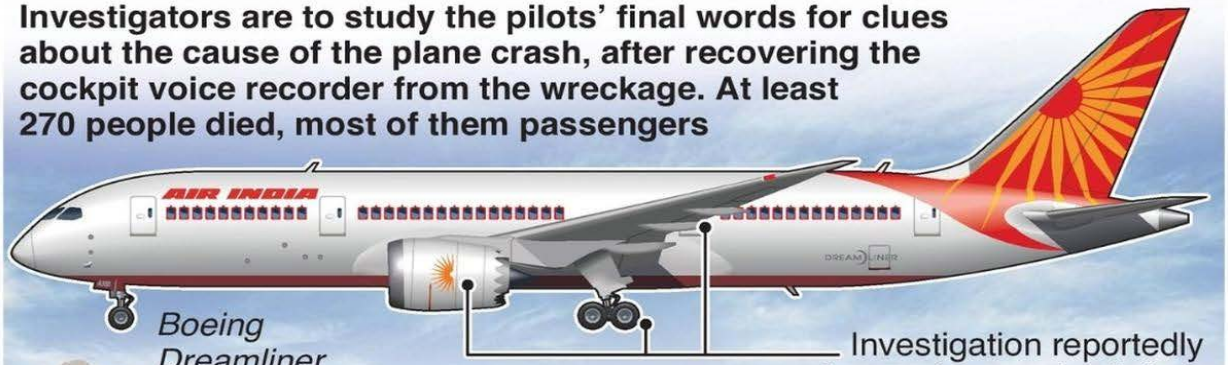
3. Enlist key findings of preliminary report on Ahmedabad Plane crash?

- The **Aircraft Accident Investigation Bureau (AAIM)** on July 12, released its **preliminary report** into the tragic crash of **Air India 171.**

- **Here are the key takeaways from the 15-page report:**
  - Both engines shut down mid-air within seconds after takeoff - **fuel cutoff switches moved from RUN to CUTOFF one after another** in just one second. The report revealed that the fuel supply to the engines was cut off.
  - Cockpit audio confirms one pilot asked, ***"Why did you cut off?"*** The other replied, ***"I didn't".***
  - When the engines lost power, the **Ram Air Turbine - a small propeller-like device was deployed automatically to provide emergency hydraulic power**. The CCTV footage obtained by AAIB showed RAT being deployed.
  - The pilots tried to restart the engine. **N1 or engine 1 was partially recovered, but engine 2 failed to recover before impact**. The aircraft was **airborne for only 32 seconds and crashed 0.9 NM** from the runway into a hostel.
  - **Thrust levers found at idle**, but the black box shows **takeoff thrust was still engaged,** suggesting a disconnect/failure.
  - **Fuel tested clean**, and there **was no contamination** from refuelling sources.
  - **Flap setting (5 degrees)** and **gear (DOWN)** were normal for takeoff. **No bird activity or weather issues** - clear skies, good visibility, light winds.
  - The AAIB report said the **credentials of the pilots were clear** and both were **medically fit and rested**, with adequate experience on the type.
  - **No immediate sabotage evidence**, but a known FAA advisory on a possible **fuel switch flaw existed** - inspections were not done by Air India. The aircraft **was within weight and balance limits** - no dangerous goods onboard.

Voice recorder from Air India flight found

Investigators are to study the pilots' final words for clues about the cause of the plane crash, after recovering the cockpit voice recorder from the wreckage. At least 270 people died, most of them passengers



Boeing Dreamliner 787-8

Investigation reportedly focused on engine failure and issues with wing flaps and landing gear

3 **13:39:13:** Plane crashes into residential quarters of BJ Medical College and Civil Hospital

2 **13.38.55:** Aircraft reaches altitude of 625ft and attains top speed of 174 knots before beginning to rapidly descend

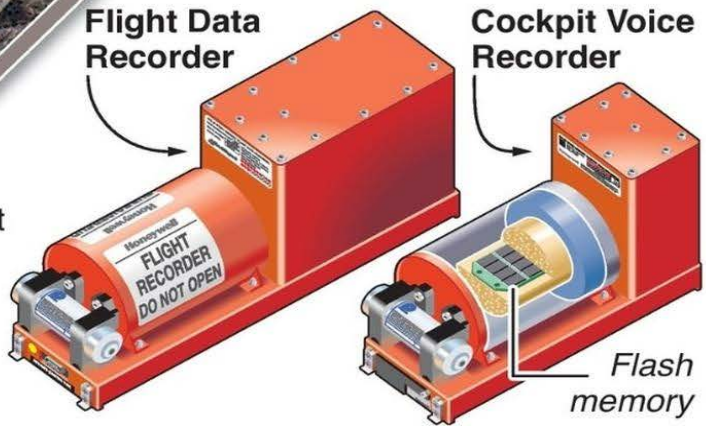
1 **13:38:40 local time:** ***Flight AI-171*** takes off from ***Sardar Vallabhbhai Patel International Airport.*** Seconds later, pilot issues "Mayday" distress call

Black boxes located at tail section

BLACK BOXES
Record flight parameters, cockpit sounds and conversations.
Can withstand impact 3,400 times force of gravity and temperatures up to 1,100°C

Flight Data Recorder

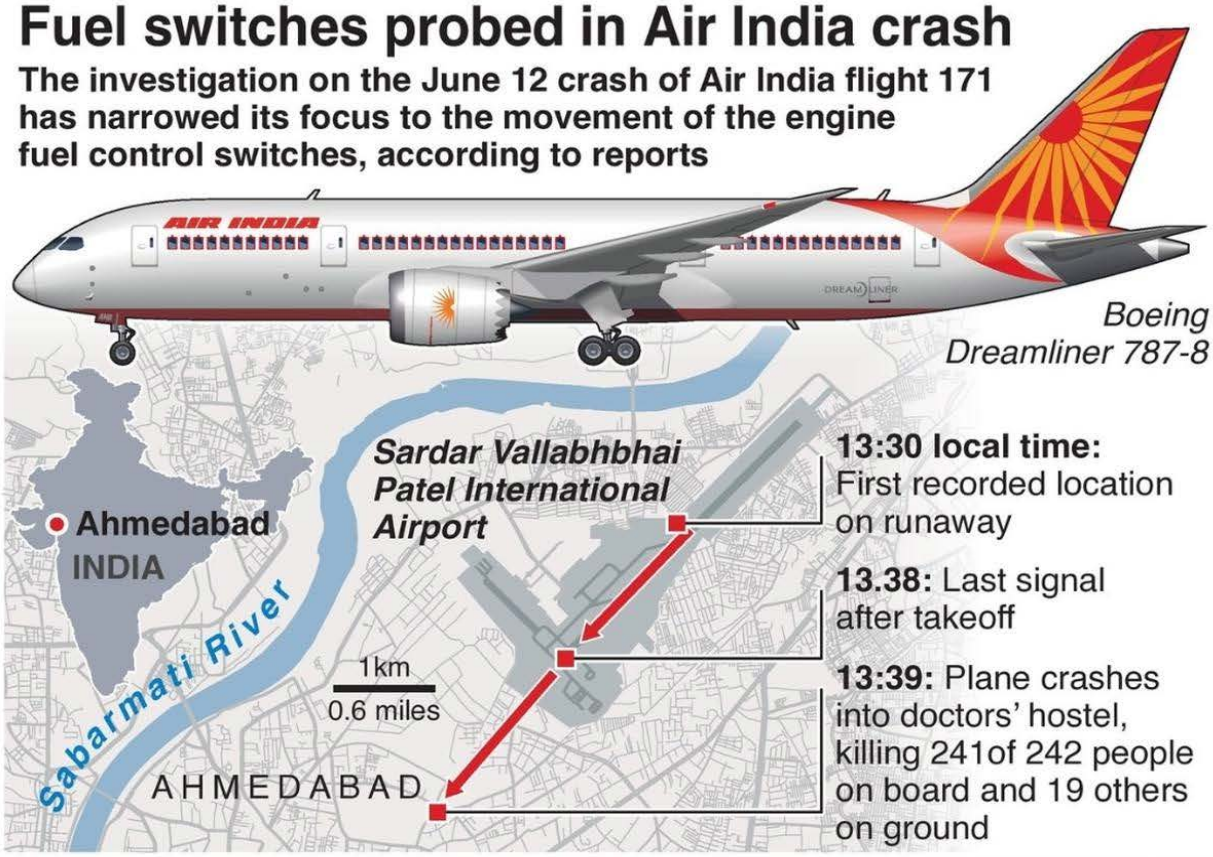
Cockpit Voice Recorder

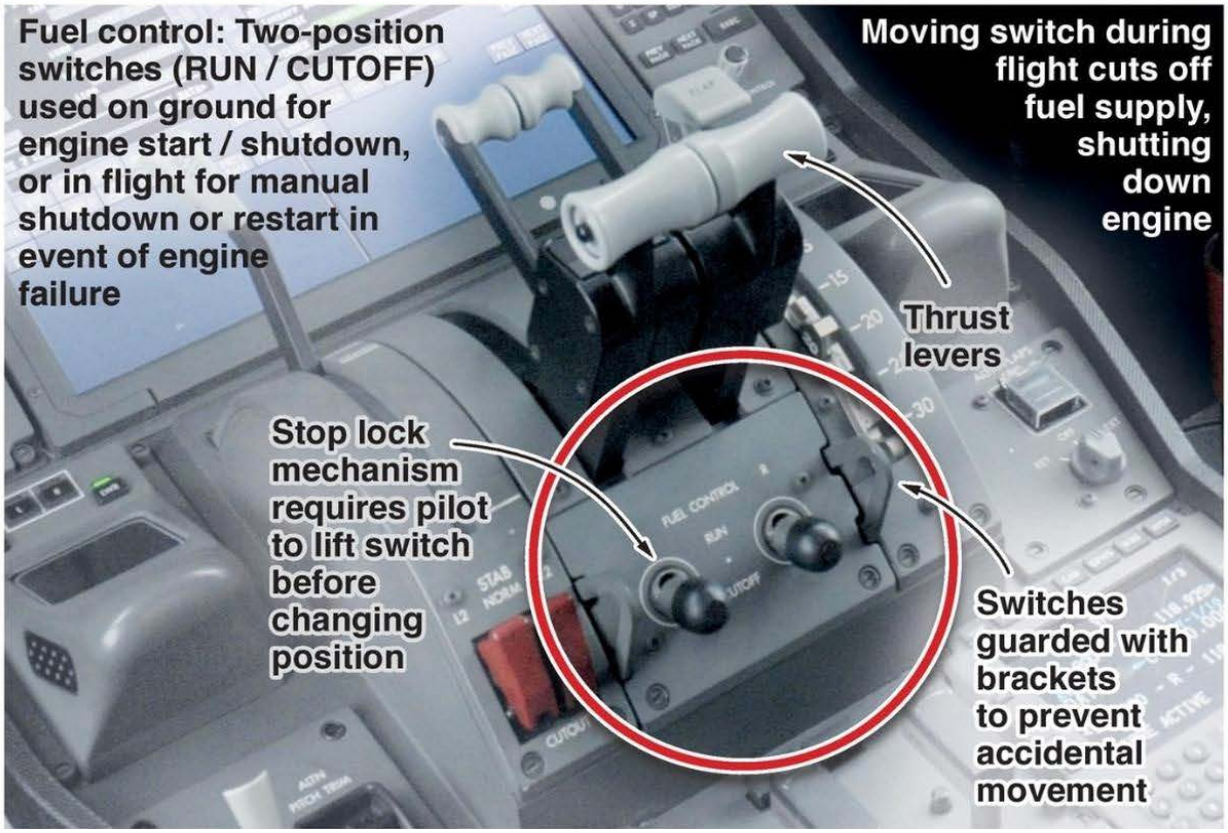


Flash memory

Fuel switches probed in Air India crash

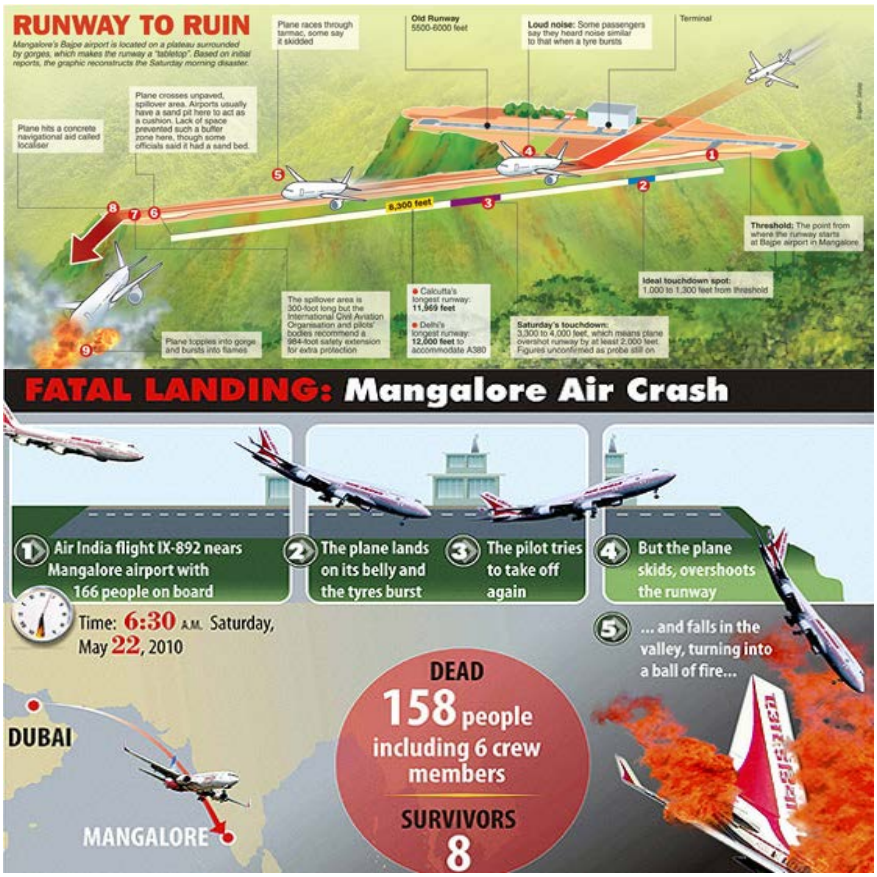
The investigation on the June 12 crash of Air India flight 171 has narrowed its focus to the movement of the engine fuel control switches, according to reports





4. Enlist major aviation accidents in India?

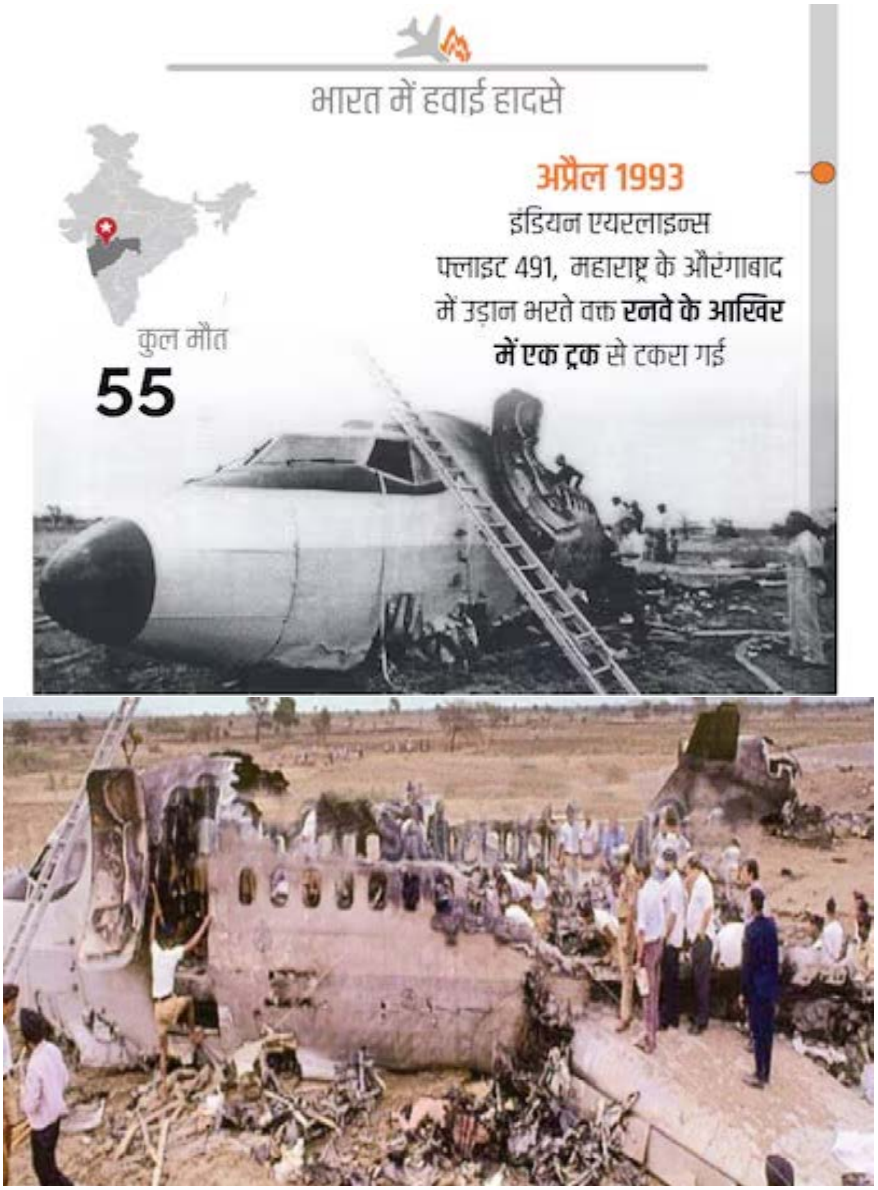
Aviation accidents	Description
August 7, 2020: Calicut (Kozhikode) Air Crash	• **Air India Express Flight 1344** from Dubai crashed while landing at **Calicut International Airport**, killing 21 people. • The aircraft skidded off a wet runway and broke into two.  
May 22, 2010: Mangalore Air Crash	• **Air India Express Flight 812** overshot the runway at **Mangalore**, resulting in 158 deaths. • The **aircraft broke** apart after falling into a gorge.

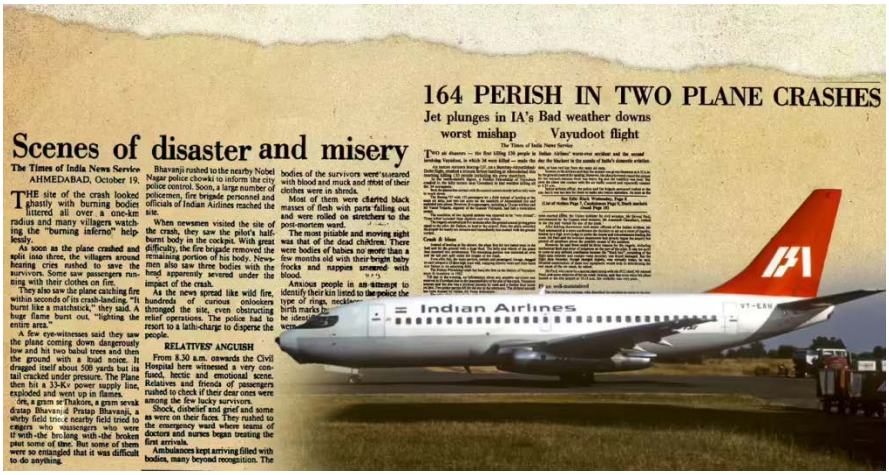


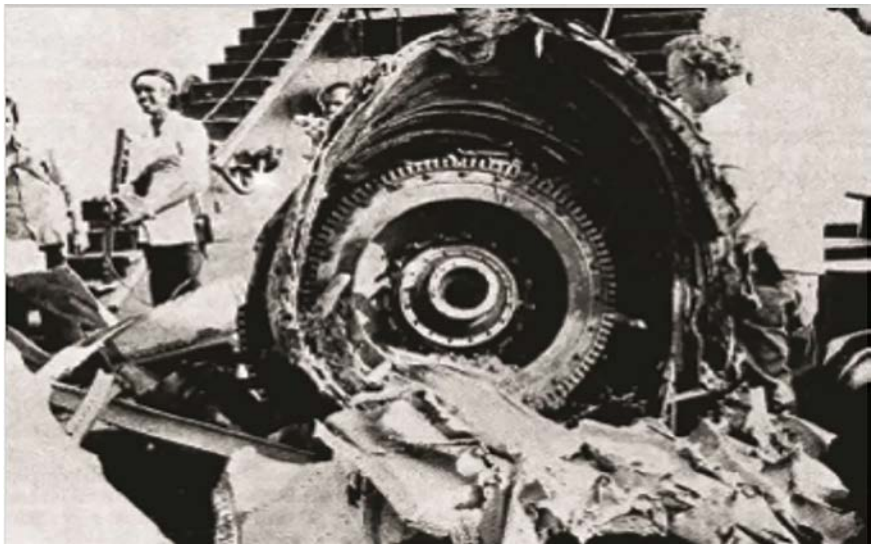
July 17, 2000: Patna Air Crash

- A **Boeing 737 on Alliance Air Flight 7412** crashed during landing at **Patna**, killing over 60 people.
- Loss of control due to **pilot error** was the cause.

November 12, 1996: Charkhi Dadri Mid-Air Collision	• **Saudi Arabian Airlines** Boeing 747 and **Kazakhstan Airlines Ilyushin Il-76** collided near Delhi, killing all 349 people on both aircraft. • The cause was **pilot error** and **miscommunication** with **air traffic control.** 
April 26, 1993: Aurangabad Air Crash	• **Indian Airlines Flight 491, a Boeing 737**, crashed after takeoff from **Aurangabad**, hitting a truck and power lines, killing 55 people.
August 16, 1991: Imphal Air Crash	• Indian Airline**s Flight 257** crashed near **Imphal**, killing all 69 on board.

	
February 14, 1990: Bangalore Air Crash	• **Indian Airlines Flight 605, an Airbus A320**, crashed on approach to **Bangalore**, killing 92 people.

	
October 19, 1988: Ahmedabad Air Crash:	• Indian Airlines Flight 113 crashed in Ahmedabad, killing 133.  164 PERISH IN TWO PLANE CRASHES Jet plunges in IA's Bad weather downs worst mishap Vayudoot flight Scenes of disaster and misery The Times of India News Service AHMEDABAD, October 19. THE site of the crash looked ghastly with burning bodies littered all over a one-km radius and many villagers watching the "burning inferno" helplessly. As soon as the plane crashed and split into three, the villagers around hearing cries rushed to save the survivors. Some saw passengers running with their clothes on fire. They also saw the plane catching fire within seconds of its crash-landing. "It burnt like a matchstick," they said. A huge flame burst out, "lighting the entire area." A few eye-witnesses said they saw the plane coming down dangerously low and hit two babul trees and then the ground with a loud noise. It dragged itself about 500 yards but its tail cracked under pressure. The Plane then hit a 33-Kv power supply line, exploded and went up in flames. Orli, a gram sr Thakore, a gram sevak dratap Bhavanji Pratap Bhavanji, a worby field trice nearby field tried to rescue passengers who were ill with the broken past some of them. But some of them were so entangled that it was difficult to do anything. Bhavanji rushed to the nearby Nobel Nagar police chowki to inform the city police control. Soon, a large number of policemen, fire brigade personnel and officials of Indian Airlines reached the site. When newsmen visited the site of the crash, they saw the pilot's half-burnt body in the cockpit. With great difficulty, the fire brigade removed the remaining portion of his body. Newsmen also saw three bodies with the head apparently severed under the impact of the crash. As the news spread like wild fire, hundreds of curious onlookers thronged the site, even obstructing relief operations. The police had to resort to a lathi-charge to disperse the people. RELATIVES' ANGUISH From 8.30 a.m. onwards the Civil Hospital here witnessed a very confused, hectic and emotional scene. Relatives and friends of passengers rushed to check if their dear ones were among the few lucky survivors. Shock, disbelief and grief and some as were on their faces. They rushed to the emergency ward where teams of doctors and nurses began treating the first arrivals. Ambulances kept arriving filled with bodies, many beyond recognition. The bodies of the survivors were smeared with blood and muck and most of their clothes were in shreds. Most of them were clarted black masses of flesh with parts falling out and were rolled on stretchers to the post-mortem ward. The most pitiable and moving sight was that of the dead children. There were bodies of babies no more than a few months old with their bright baby frocks and nappies smeared with blood. Anxious people in an attempt to identify their kin listed to the police the type of rings, necklaces, birth marks, etc.
June 21, 1982: Bombay Air Crash	• Air India Flight 403 crashed at Bombay airport, killing 17.  INDIAN EXPRESS 17 dead as Air India Boeing crashes at Bombay airport Zail Singh files nomination LD men clash with India and Pakistan settle waters issue

January 1, 1978: Bombay Air Crash	• **Boeing 747 on Air India Flight 855** crashed into the **Arabian Sea** after takeoff from **Mumbai**, killing all 213 on board. 

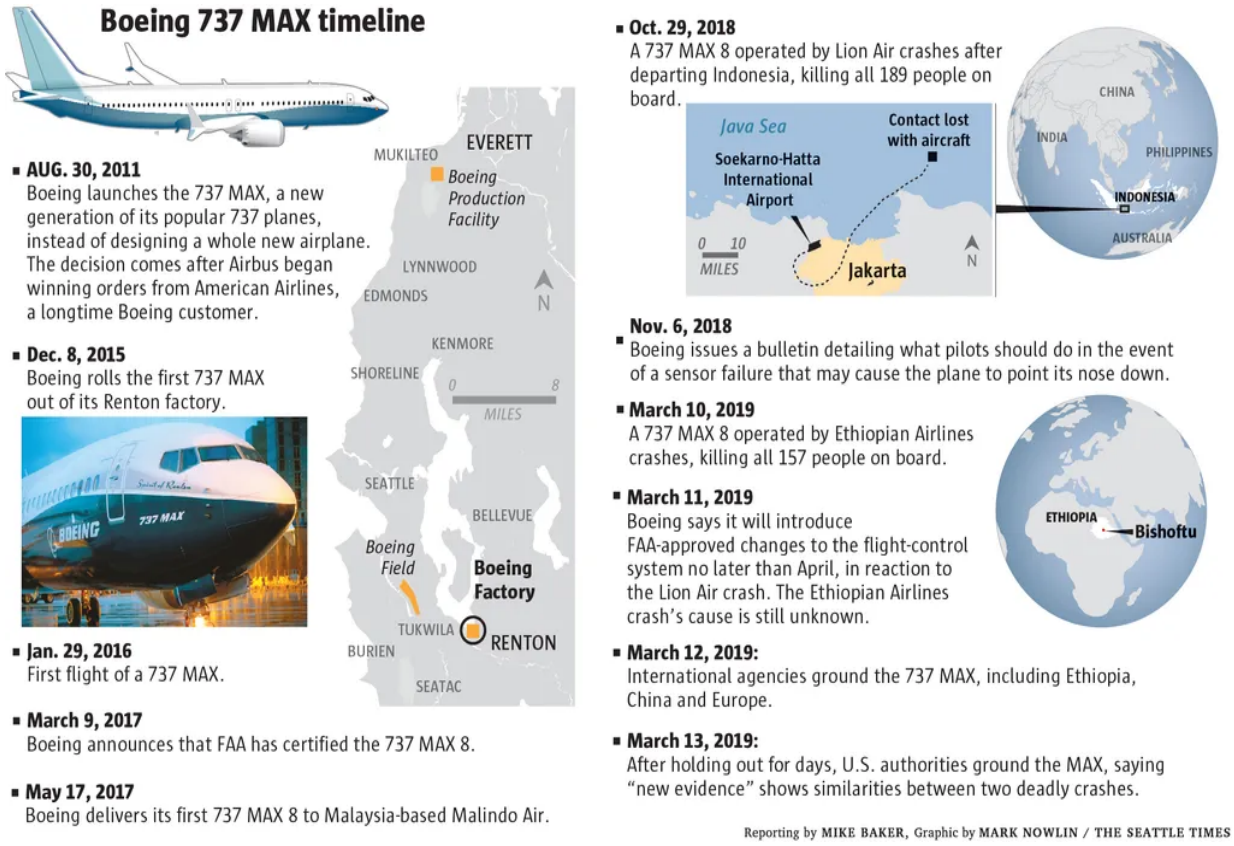

World's Best
Airlines 2023
The Airline Excellence Awards, judged by five editors with decades of industry experience, combines major safety and government audits, with 11 key criteria that include: fleet age, passenger reviews, profitability, investment rating, product offerings, and staff relations.
1. Air New Zealand
2. Qatar Airways
3. Etihad Airways
4. Korean Air
5. Singapore Airlines
6. Qantas
7. Virgin Australia
7. Virgin Atlantic
8. EVA Air
9. Cathay Pacific Airways
10. Emirates
11. Lufthansa
11. Swiss International Air Lines
12. Scandinavian Airlines
13. TAP Air Portugal
14. All Nippon Airways
15. Delta Air Lines
16. Air Canada
17. British Airways
18. Jet Blue Airways
19. Japan Airlines
20. Vietnam Airlines
RankingRoyals

5. Mention major accidents of Air India?

- **Previous instances of fatal Air India crashes include:**
  - **1966: Flight 101**, a Boeing 707, crashed into Mont Blanc in the European Alps, killing all 117 people on board.
  - Among the victims was **Dr. Homi Jehangir Bhabha,** the founder and chairman of the **Atomic Energy Commission of India.**
  - **1978: Flight 855**, a Boeing 747, crashed into the Arabian Sea shortly after takeoff, killing all 213 passengers and crew.

- **1985: Flight 182,** a Boeing 747, crashed when a bomb was detonated on board, killing all 329 people on board.
- **1982: Flight 403,** a Boeing 707, crashed during a hard landing, killing 17 people.

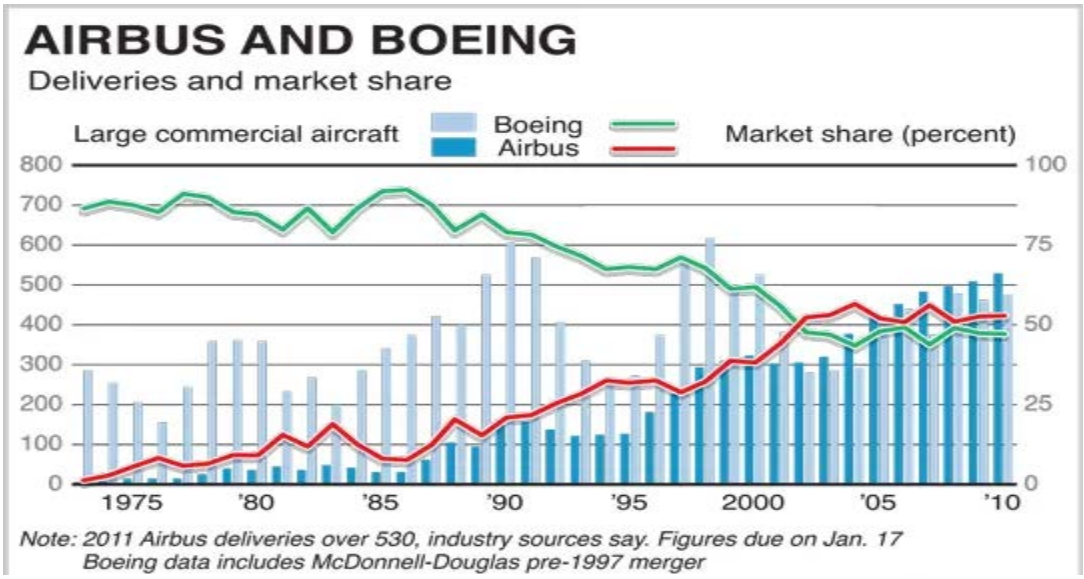
6. Mention timeline of Boeing 737 MAX disasters?

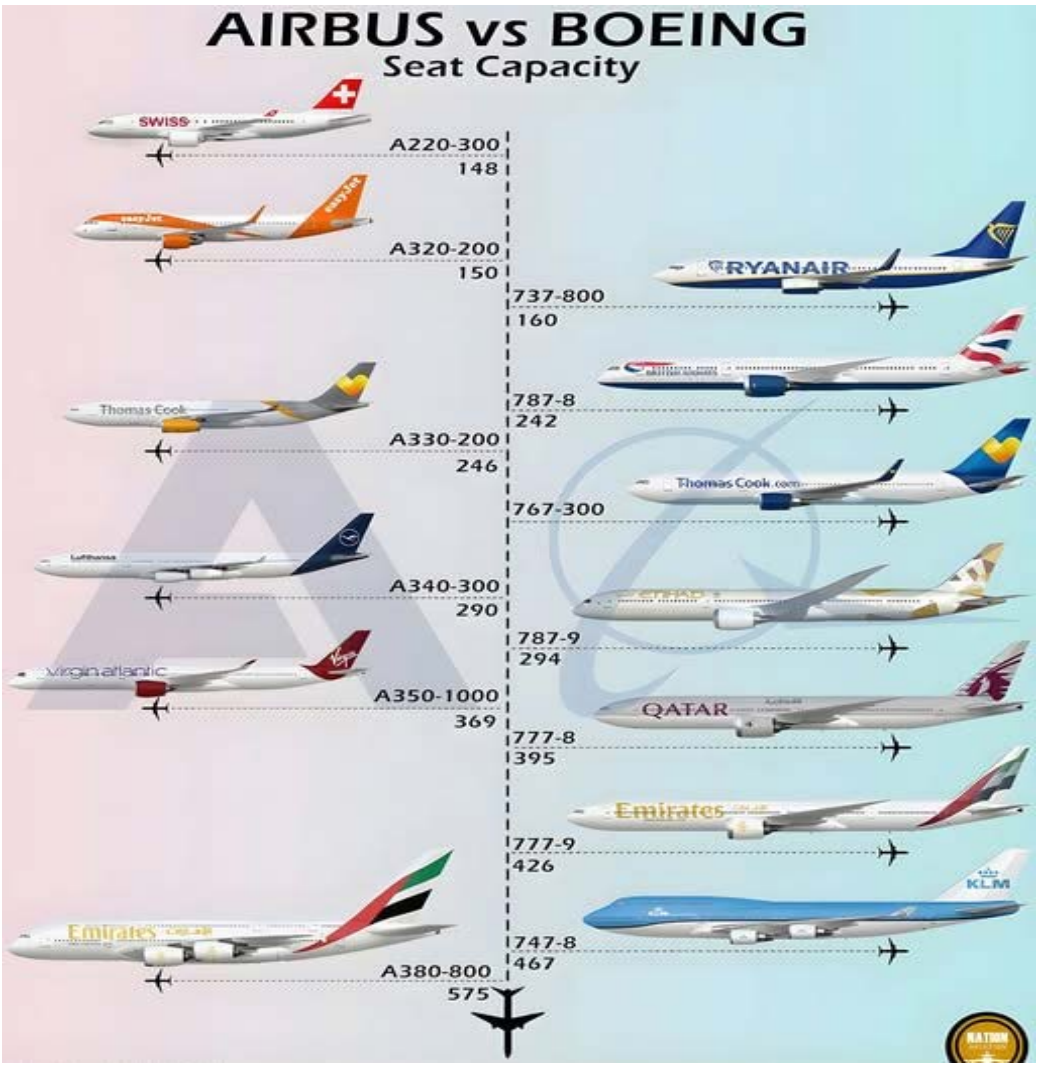


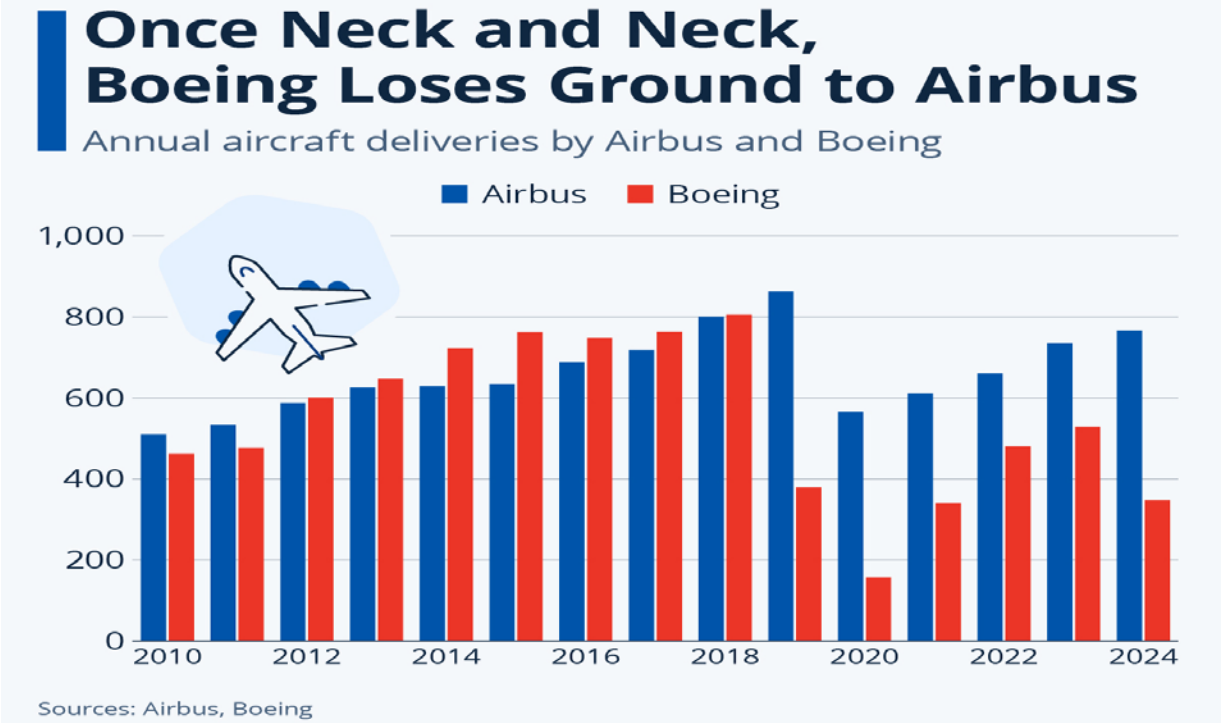
7. Mention about important aircraft manufacturers?

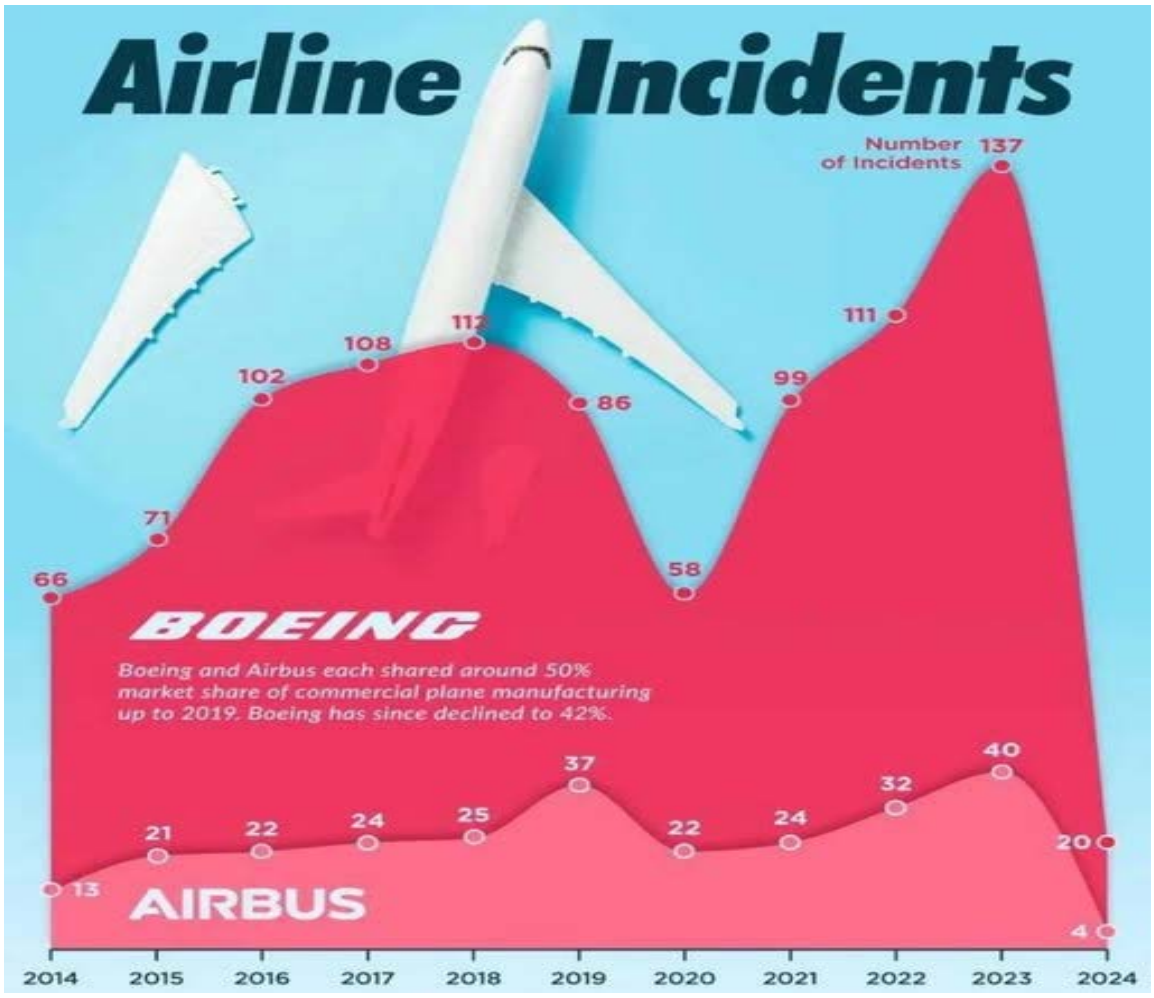
- The **key aircraft manufacturers globally are Airbus and Boeing**, who dominate the **commercial airliner marke**t, and also include **Embraer, Bombardier, and Lockheed Martin.**
- **Airbus** controls **approximately 60.4%** of the market, while **Boeing holds around 40.6%.**

8. Enlist key differences between Boeing and Airbus?

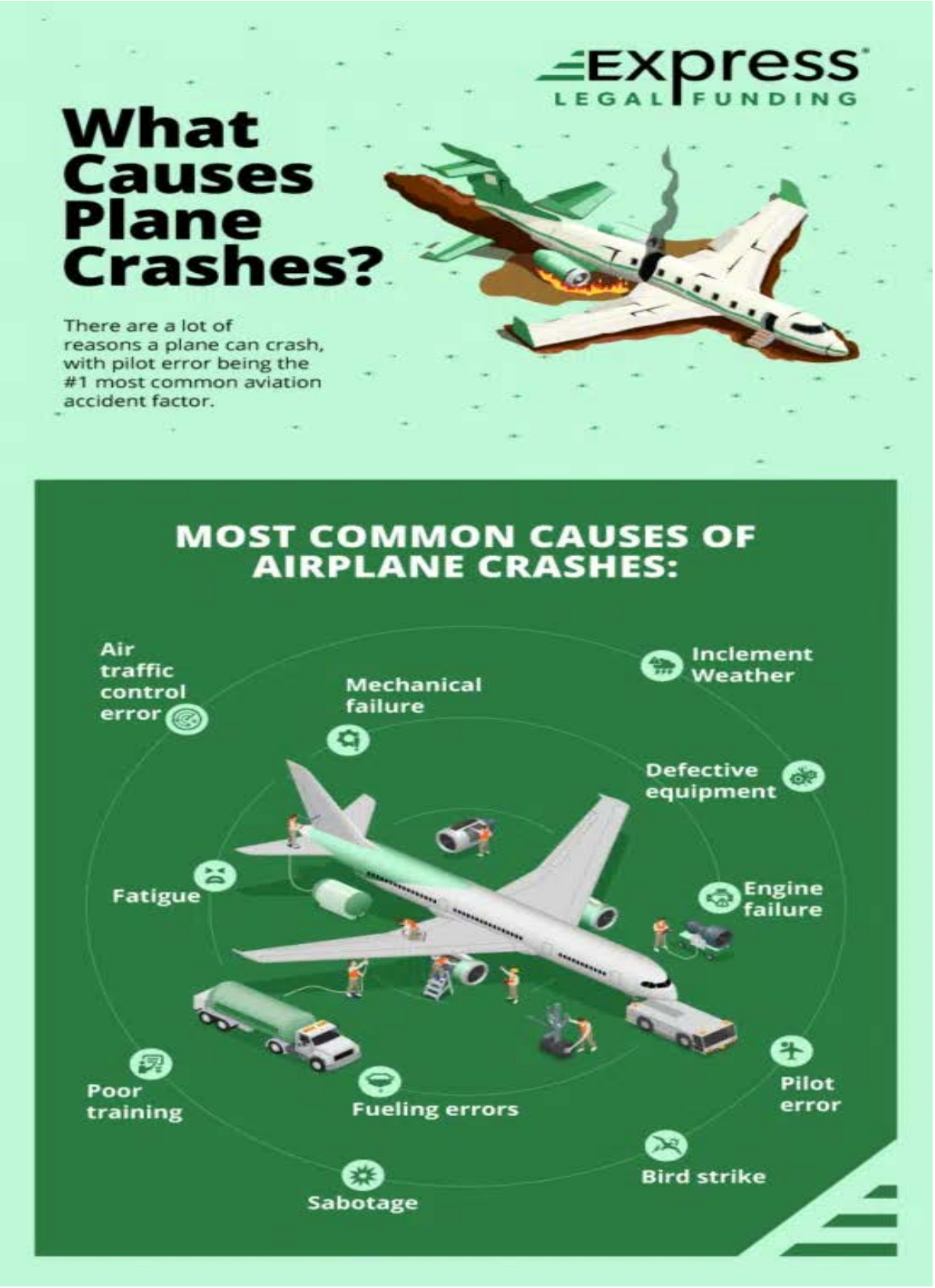


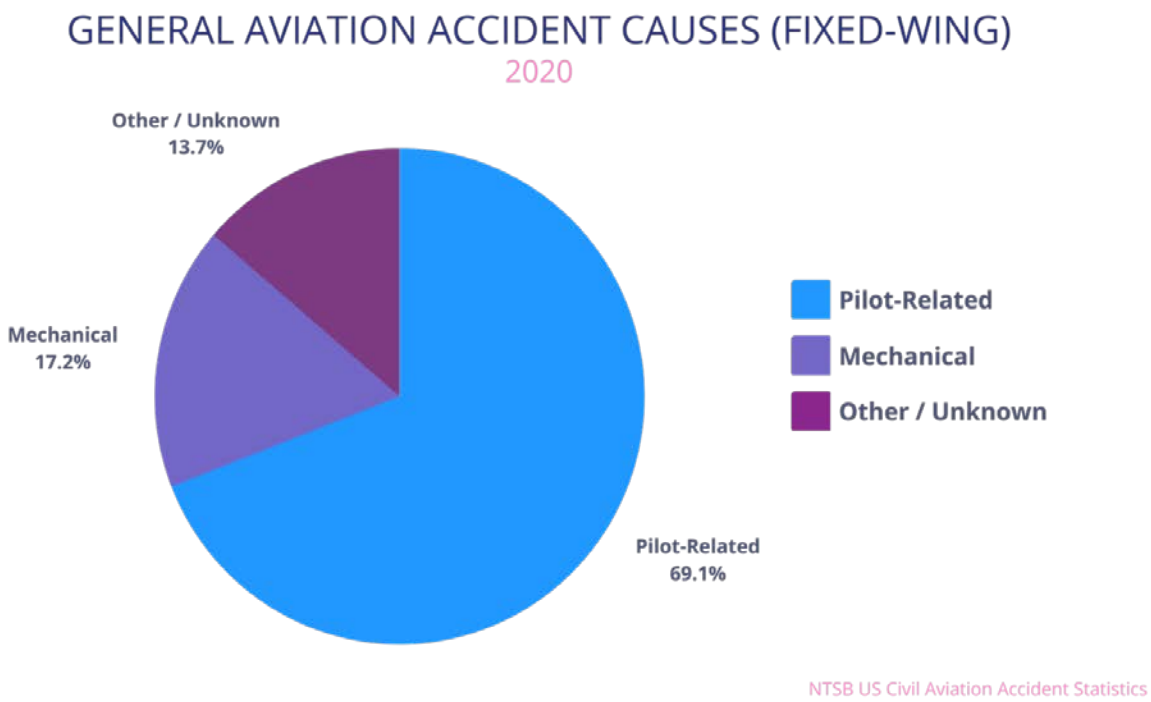


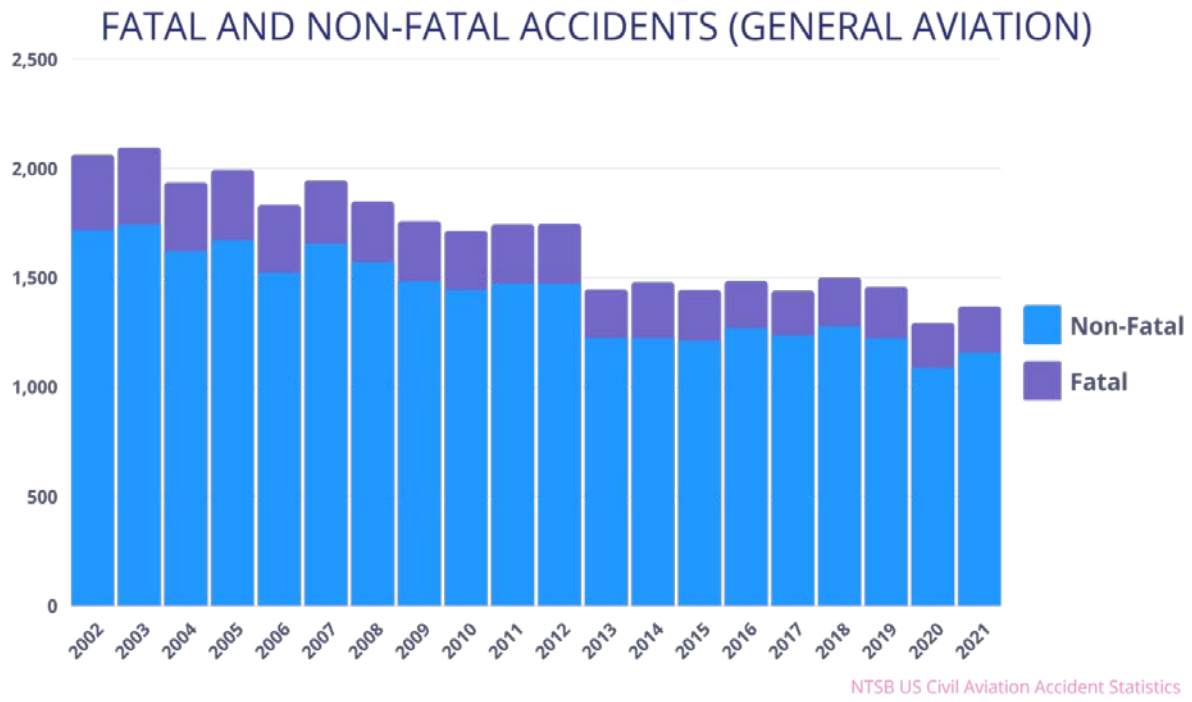

Once Neck and Neck, Boeing Loses Ground to Airbus
Annual aircraft deliveries by Airbus and Boeing
Airbus
Boeing
1,000
800
600
400
200
0
2010
2012
2014
2016
2018
2020
2022
2024
Sources: Airbus, Boeing


Airline Incidents
Number of Incidents
66
71
102
108
112
86
58
99
111
137
BOEING
Boeing and Airbus each shared around 50% market share of commercial plane manufacturing up to 2019. Boeing has since declined to 42%.
13
21
22
24
25
37
22
24
32
40
20
4
AIRBUS
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024

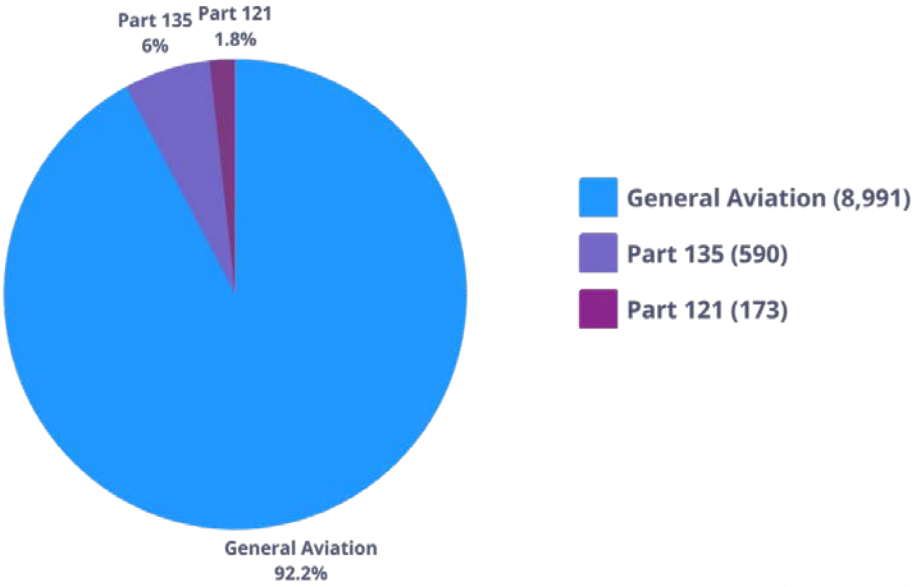
9. Mention about the causes of aviation accidents?




GENERAL AVIATION ACCIDENT CAUSES (FIXED-WING)
2020
Other / Unknown
13.7%
Mechanical
17.2%
Pilot-Related
69.1%
Pilot-Related
Mechanical
Other / Unknown
NTSB US Civil Aviation Accident Statistics

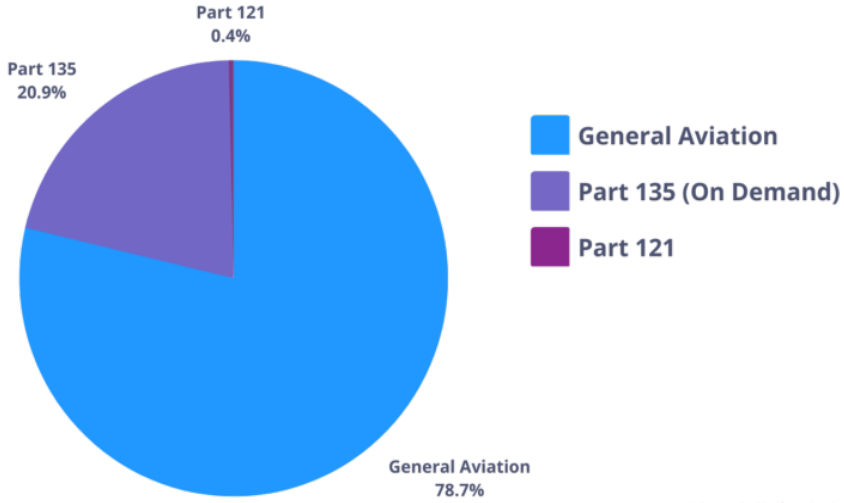

FATAL AND NON-FATAL ACCIDENTS (GENERAL AVIATION)
2,500
2,000
1,500
1,000
500
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Non-Fatal
Fatal
NTSB US Civil Aviation Accident Statistics

AIRCRAFT ACCIDENT FATALITIES
2002 - 2021

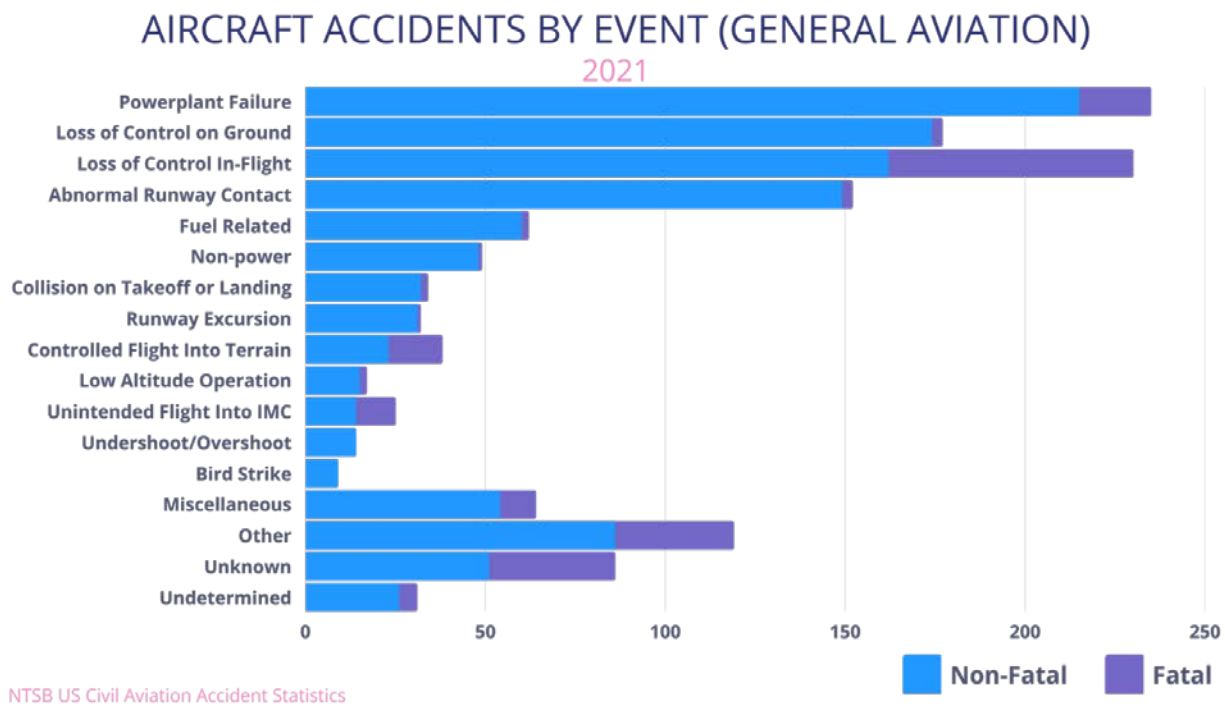


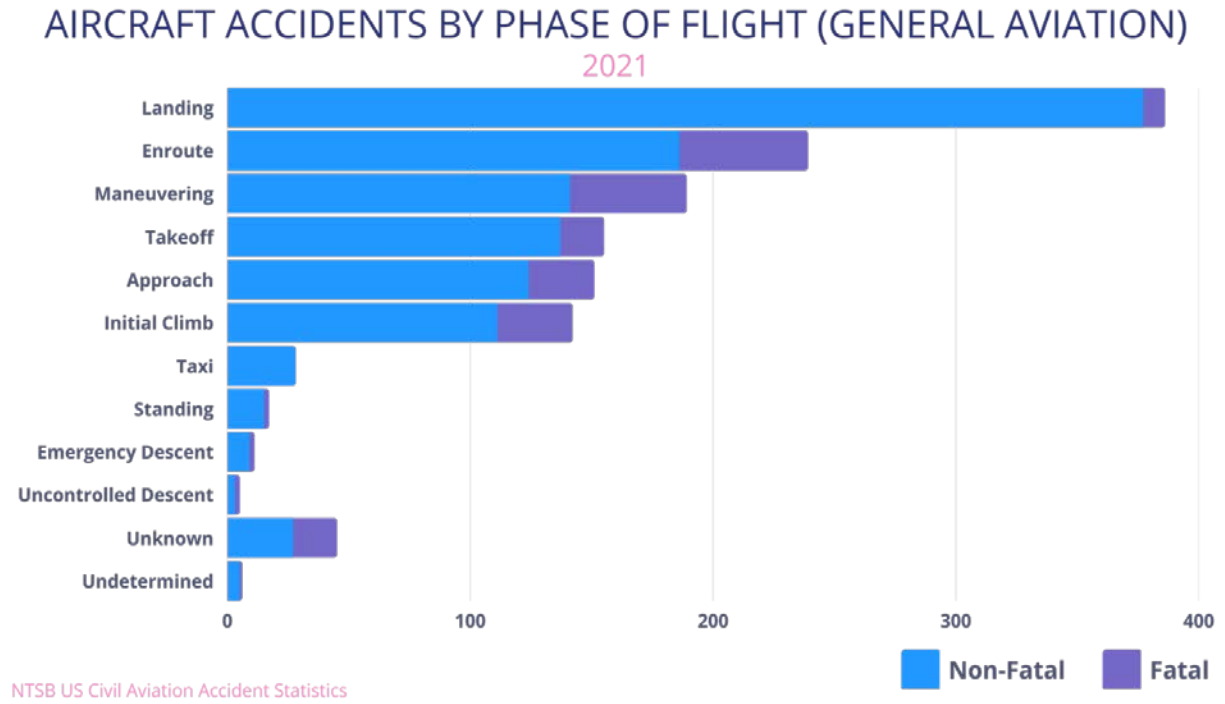
NTSB US Civil Aviation Accident Statistics

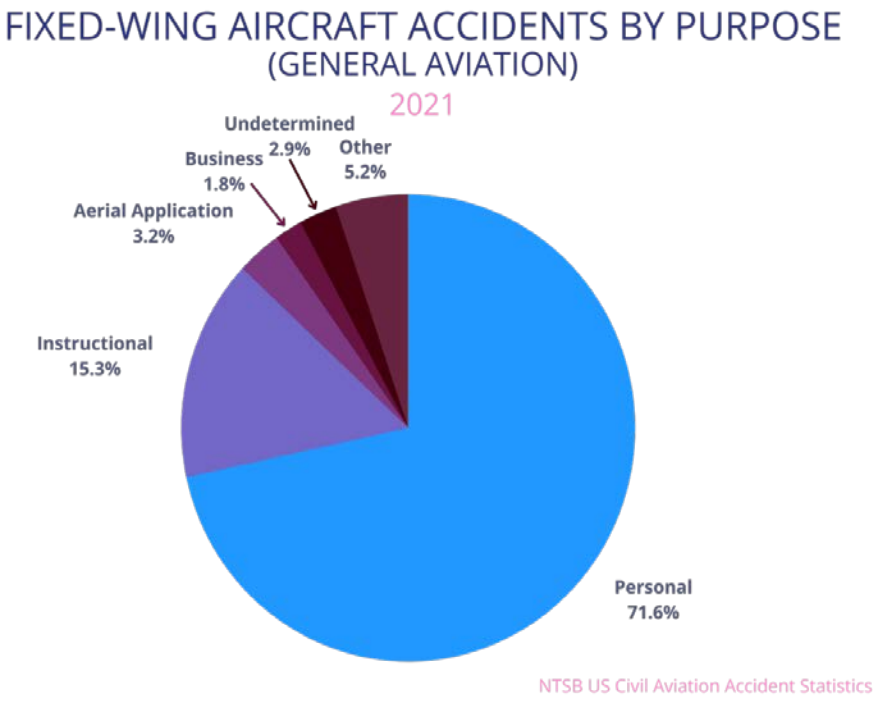
FATAL ACCIDENTS PER 100,000 FLIGHT HOURS
2002 - 2021



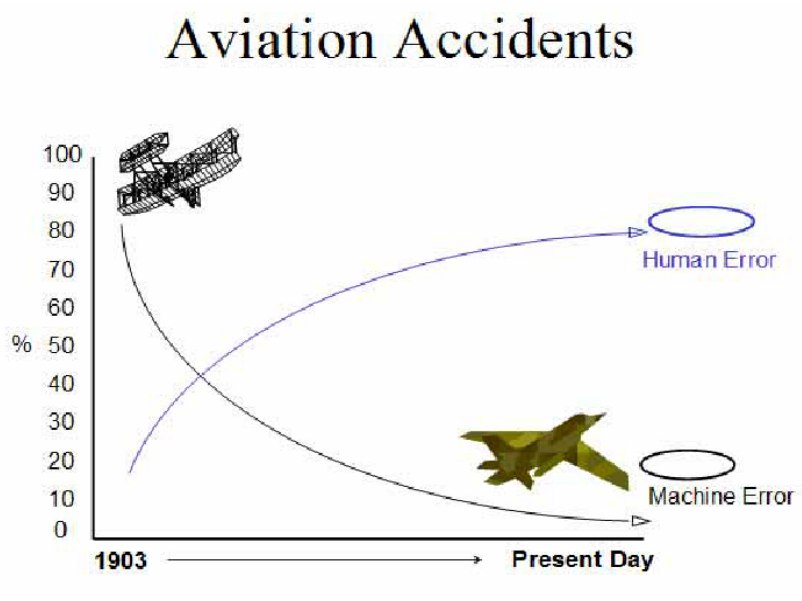
NTSB US Civil Aviation Accident Statistics


AIRCRAFT ACCIDENTS BY EVENT (GENERAL AVIATION)
2021
Powerplant Failure
Loss of Control on Ground
Loss of Control In-Flight
Abnormal Runway Contact
Fuel Related
Non-power
Collision on Takeoff or Landing
Runway Excursion
Controlled Flight Into Terrain
Low Altitude Operation
Unintended Flight Into IMC
Undershoot/Overshoot
Bird Strike
Miscellaneous
Other
Unknown
Undetermined
0
50
100
150
200
250
Non-Fatal
Fatal
NTSB US Civil Aviation Accident Statistics


AIRCRAFT ACCIDENTS BY PHASE OF FLIGHT (GENERAL AVIATION)
2021
Landing
Enroute
Maneuvering
Takeoff
Approach
Initial Climb
Taxi
Standing
Emergency Descent
Uncontrolled Descent
Unknown
Undetermined
0
100
200
300
400
Non-Fatal
Fatal
NTSB US Civil Aviation Accident Statistics



Reasons	Description
Human Errors in Aviation	• **Pilot error** is the number one cause of **aviation accidents.** • **Piloting an aircraft requires** lengthy training, a knowledge of the **mechanical components of an aircraft, and hand-eye coordination skills** to effectively and safely maneuver an aircraft. • Pilots also have to think ahead. • Planning flights, **checking the weather**, and **anticipating changes** are all keys to being a safe pilot. • If a pilot doesn't plan the flight properly, gets into bad weather, or doesn't anticipate issues then **airplane crashes** can happen.

	 • Occasionally pilots become **disoriented,** especially while **operating in clouds**, under **Instrument Flight Rules (IFR).** • **Pilot disorientation** can lead to stalls or spins that lead to crashes.
Mistakes By Crew Members	• **Cockpit Resource Management** is key to successful and safe aviation operation in **larger aircraft** with multiple crew members. • This involves dividing up cockpit duties and making sure that each pilot in the **cockpit knows their job.** • **Managing a cockpit** also involves making sure each pilot feels confident and comfortable in speaking up if something in the **cockpit appears wrong or unsafe.** • Airlines spend hours **training pilots** on cockpit resource management. • If pilots don't follow good c**ockpit resource management skills** then air crashes can occur.

<table>
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<tr>
<td>Air Traffic Controller Negligence</td>
<td>

Air traffic controllers play a very important role in aviation safety.
Controllers help keep aircraft separated from each other and guide flights through congested airspace.
Controllers communicate with pilots giving them flight headings and designating the altitude at which an aircraft must fly.
If a controller gives a pilot wrong information or fails to maintain flight separation, then collisions can occur.
Air traffic control data and transcripts are retained for a limited period of time after an accident.

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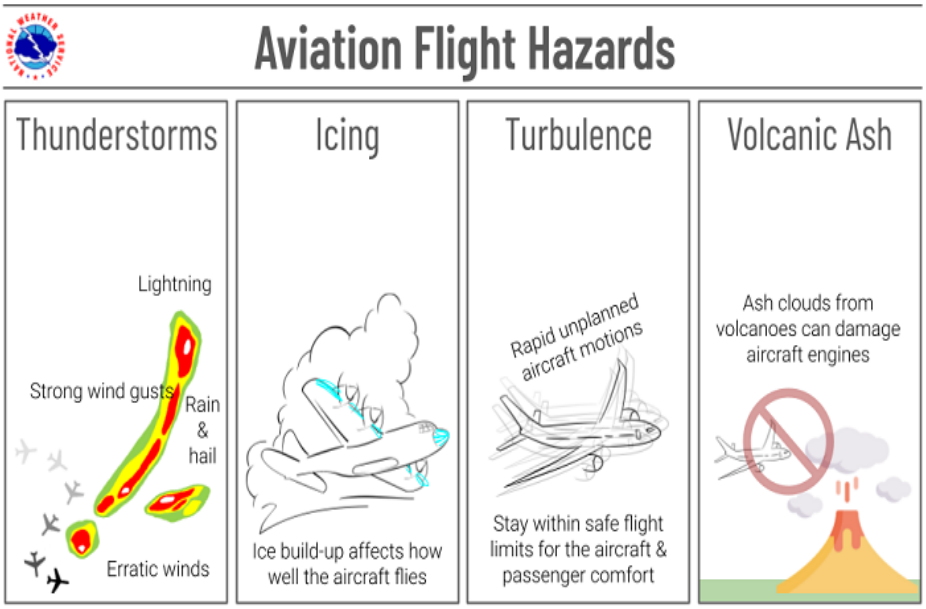
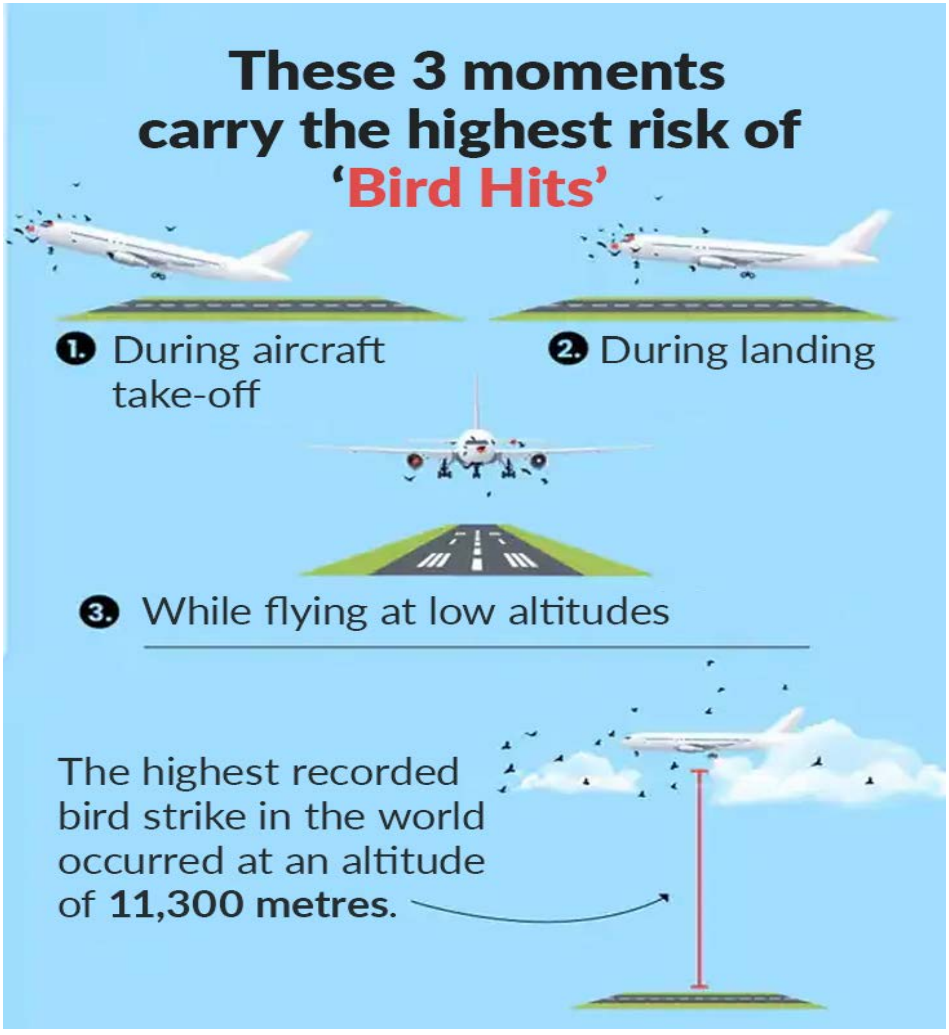
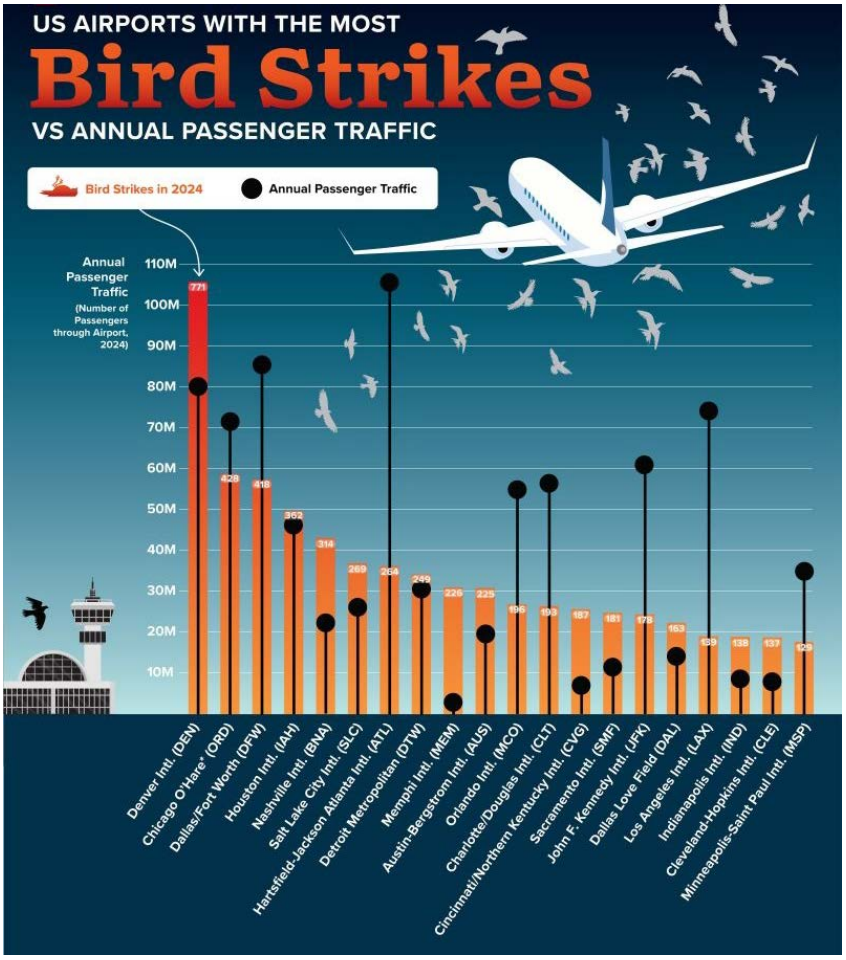
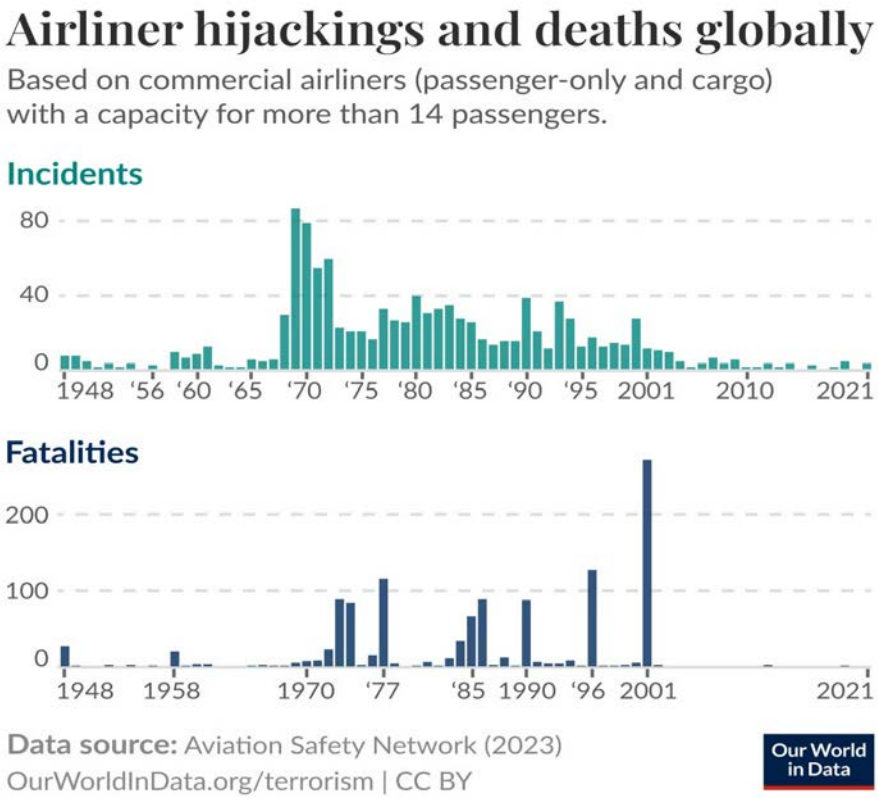
- It is important to **request** and **obtain this information** as soon as possible after a collision.

Weather Conditions	• **Weather** is often a key factor in **aviation accidents.**  • It's the **pilot's responsibility t**o know and **understand the weather** along a flight route. • **Air traffic controllers** share responsibility for providing weather information to pilots. • If **wrong information** is obtained or flights are not planned by following the expected **weather conditions**, then accidents can occur. • Obtaining information about the **weather after an accident** is also important.
Bird Strike	• A **bird strike** is strictly defined as a collision between a bird and an aircraft which is in flight or on a **take of**f or **landing roll.**


CAUSES OF
BIRD STRIKES
BIRD MIGRATION SEASONS & ROUTES
AIRPORT LOCATION & ENVIRONMENT
FLIGHT ALTITUDE
DAY VS. NIGHT
INCREASING FLIGHT NUMBERS


These 3 moments carry the highest risk of 'Bird Hits'
1. During aircraft take-off
2. During landing
3. While flying at low altitudes
The highest recorded bird strike in the world occurred at an altitude of 11,300 metres.


US AIRPORTS WITH THE MOST
Bird Strikes
VS ANNUAL PASSENGER TRAFFIC
Bird Strikes in 2024
Annual Passenger Traffic
Annual Passenger Traffic
(Number of Passengers through Airport, 2024)
110M
100M
90M
80M
70M
60M
50M
40M
30M
20M
10M
771
428
418
362
314
269
264
239
226
225
199
193
187
181
178
163
139
138
137
129
Denver Intl. (DEN)
Chicago O'Hare * (ORD)
Dallas/Fort Worth (DFW)
Houston Intl. (IAH)
Nashville Intl. (BNA)
Salt Lake City Intl. (SLC)
Hartsfield-Jackson Atlanta Intl. (ATL)
Detroit Metropolitan (DTW)
Memphi Intl. (MEM)
Austin-Bergstrom Intl. (AUS)
Orlando Intl. (MCO)
Charlotte/Douglas Intl. (CLT)
Cincinnati/Northern Kentucky Intl. (CVG)
Sacramento Intl. (SMF)
John F. Kennedy Intl. (JFK)
Dallas Love Field (DAL)
Los Angeles Intl. (LAX)
Indianapolis Intl. (IND)
Cleveland-Hopkins Intl. (CLE)
Minneapolis-Saint Paul Intl. (MSP)

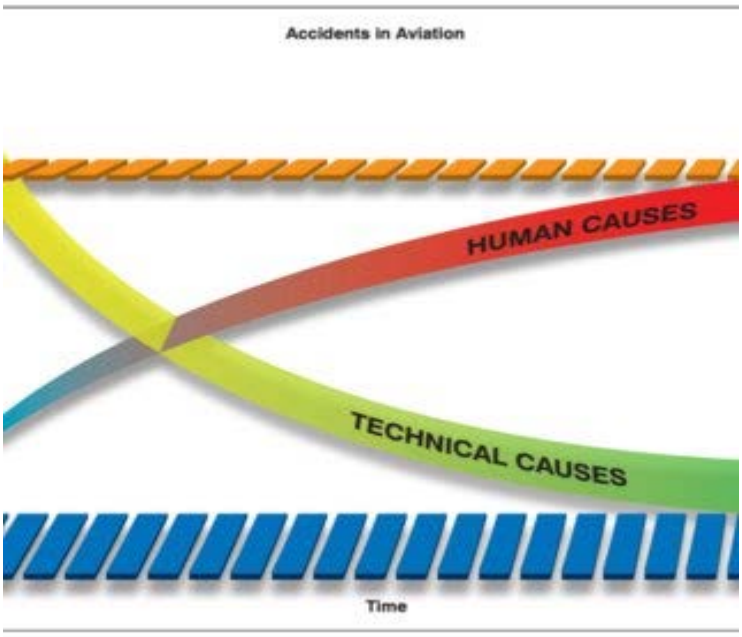
Sabotage and Hijackers	• Despite the overall safety of **commercial flights, sabotage and hijackers** are two rarer causes of airplane crashes. • Both types of dangers pose a **risk of fatalities in mid-air** and an increased chance of crashing (even when **hijackers intend to land the plane**). 
Improper Aircraft Maintenance	• **Proper aircraft maintenance** is extremely important. • There are many **rules and regulations** governing the maintenance of an aircraft. • **Airplane mechanics** must follow checklists, guidelines, and inspection requirements. • Inspection requirements vary depending on the type of **FARs the flight** is being operated under. • It can be difficult to determine if a **mechanical issue** caused an aircraft to crash.

	• **Post-accident inspections** are crucial to understanding if a mechanical issue was related to the crash.
Aircraft Design Defects	• **Aircraft designs** vary greatly. • **Airplanes have different types of engines, propellers, wings, and cockpit instrumentation.** • If any of these **components** are not designed properly, crashes can occur. • Aircraft must be designed to **withstand turbulence, weather, and other types of different environments.** • These designs are usually thoroughly tested before being put into **production.** • A **defectively designed aircraft** can lead to crashes.
Instrument Flight Factors	• Depending on the weather conditions, aircraft will be governed by **Visual Flight Rules (VFR) or Instrument Flight Rules (IFR).** • **Flying VFR** a pilot primarily uses eyesight and visual cues outside the **cockpit to safely fly the aircraft.** • Operating aircraft under **Instrument Flight Rules (IFR)** involves specialized knowledge and skill. • **Flying aircraft** within clouds requires pilots to rely on cockpit instruments to **safely maneuver** the aircraft. • **Attitude indicators, altimeters, airspeed, and heading indicators** are all instruments pilots use to keep an aircraft straight and level while flying in clouds.

	• Understanding these **instruments and how pilots use them** are often important in finding how a crash occurred.
Glide Slope Indicators	• **Landing an aircraft** while cloud cover exists at an airport requires an **Instrument Landing System (ILS) or GPS approach.** • These landing systems will provide a signal to aircraft that gives a **glide slope path to follow from the air down** to the runway. • Getting below the **glide slope** can cause collisions with terrain or ground obstacles. • **IFR-trained pilots** spend many hours training to properly follow **glide slope indicators.** • Failing to follow a **glide slope path** can cause aviation accidents.
GPS for aircraft	• **GPS** has become the **primary navigation system for aircraft.** • GPS equipment is standard in **nearly every aircraft.** • **GPS** can be **programmed** to give the **aircraft's autopilot headings** and **altitudes** to follow so that the pilot does not have to hand fly the aircraft the entire flight. • While **GPS is an essential tool in aviation**, it can also be a distraction for pilots, and if not **programmed correctly** can cause an aircraft to get off an assigned heading or altitude. • **GPS** also can be used in **IFR conditions** to give pilots the information they need to safely land an **aircraft** where cloud cover exists over an airport.

10. How human error leads to aircraft accidents?

- According to the **Federal Aviation Administration (FAA)**, human error is the leading cause of both **commercial airline crashes and general aircraft accidents**.
- More than **88% of all general aviation accidents** are attributed to human error, especially due to **loss of control by the pilot during flight.**



Human Errors	About
Fatigue and Stress	• All **aircraft employees** work under immense pressure to fulfill their **duties flawlessly**. • **Working for long hours with irregular shifts** can cause **mental exhaustion.** • This can result in **impaired judgment** and **poor situational awareness.** • **Stress caused** by a busy professional life can **significantly hinder decision-making and exacerbate** the risk of errors.

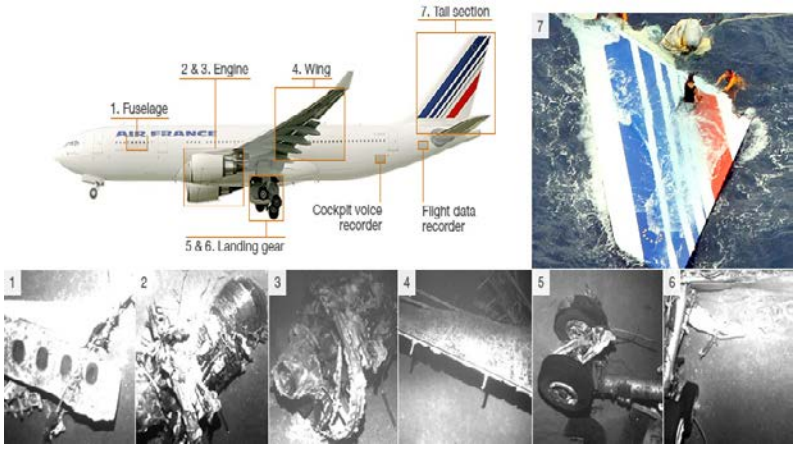
Communication Breakdown	• **Aviation is a complex process.** • It heavily relies on **timely and precise communication.** • **Unclear instructions and misunderstandings** due to language barriers can have adverse outcomes. • From the **aircraft's cockpit** to the command tower, **effective exchange of information is key for averting accidents.**
Decision-Making Errors	• **Pilots** always make split-second judgments in **high-pressure situations.** • Their **decision-making** can be affected by factors like **excess workload or emotional state, causing judgment errors.** • Additionally, **pressure to follow** instructions can interfere with **critical thinking** and increase the **risk of accidents**.
Pilot or Flight Crew Error	• **Pilots make countless decision**s and perform a multitude of actions while operating an aircraft, and sometimes they make mistakes. • These mistakes are defined as **either tactical errors, which are based in decision-making**, or operational errors, which are a result of **poor training.** • Flight crew members can also **make in-flight errors** that result in the injury of **airplane passengers.** • **Examples of errors by pilots or flight crew members include the following:**

	▪ Flying under the **influence of drugs or alcohol** ▪ Pilots experiencing **fatigue** ▪ **Confusion** when using **automated flight systems** ▪ Lack of proper training for **pilots or flight crew** ▪ Skimming or **skipping pre-flight** or pre-landing checklists ▪ **Insufficient of communication** between flight crew members ▪ Negligence of **flight crew members**
Air Traffic Controller Error	• **Air traffic controllers**, employed or **sub-contracted by the FAA**, **monitor and regulate all aspects of airplanes** in the air and on the runway. • Their job is to **direct air traffic flow and keep planes** at a safe distance from one another. • **Errors on the part of air traffic controllers include the following:** ▪ **Understaffing** ▪ **Fatigue** ▪ **Inadequate training** ▪ **Failure to issue safety alerts or warnings** ▪ **Incorrectly guiding pilots** ▪ **Poor coordination between air traffic controllers**

Aircraft Maintenance Error	• **When aircraft maintenance is performed incorrectly, airplane parts can malfunction and cause dangerous flying conditions.** • **There are several potential causes of maintenance errors:** ▪ **Fatigue** ▪ **Time pressure** ▪ **Complexities of required tasks** ▪ **Use of outdated manuals** ▪ **Improper equipment or part installation** ▪ **Incorrectly followed maintenance procedures**

11. Enlist various aviation accidents caused by human factors?

Accidents due to human factors	**Description**
Tenerife Airport Disaster (1977)	• The **Tenerife airport disaster occurred on 27 March 1977**, when two Boeing 747 passenger jets collided on the runway at **Los Rodeos Airport on the Spanish island of Tenerife.** • An investigation by **Spanish authorities** concluded that the primary cause of the accident was the **KLM captain's decision** to take off in the mistaken belief that a takeoff clearance from **air traffic control (ATC)** had been issued.

	
Air France Flight 447 (2009)	• **On June 1, 2009**, at approximately 11:14 p.m. local Brazilian time, **air traffic control lost contact with Air France Flight 447** and the plane disappeared from radar. • According to the **final report on the incident by France's BEA**, , the c**rash was due to a number of temporary inconsistencies** that caused the **autopilot to disconnect** and the crew's poor response to the situation, ultimately forcing the plane into an **aerodynamic stall** from which it did not **recover.** 

Eastern Air Lines Flight 401 (1972)	• **Eastern Air Lines Flight 401** was a scheduled flight from **John F. Kennedy International Airport in Queens, New York, United States, to Miami** International Airport in Miami, Florida, United States. • Shortly before **midnight on December 29, 1972**, the **Lockheed L-1011-1 TriStar crashed into the Florida Everglades.** • The crash occurred while the entire flight crew were **preoccupied with a burnt-out landing gear indicator light.** • The captain bumped the yoke on the aircraft, causing it to **turn off the autopilot.**  • Due to the focus on the **landing gear and the minimal changes in the cockpit,** the pilots did not notice. • Because of this, the **aircraft gradually lost altitude and crashed.** This was the first hull loss and **fatal crash of a Lockheed L-1011 TriStar.**

	• It was also the **first severe widebody aircraft crash.**
Korean Air Flight 801 (1997)	• **Korean Air Flight 801 (KE801, KAL801)** was a scheduled international passenger flight operated by **Korean Air, from Gimpo International Airport**, Seoul to **Antonio B. Won Pat International Airport, Guam.** • On August 6, 1997, the **Boeing 747-300** operating the flight crashed on **Bijia Peak, south of Nimitz Hill, in Asan-Maina, Guam**, while on approach to the **destination airport**, **killing 229** of the **254 people aboard**,making it the deadliest aviation accident to occur in **American dependent territory**, and the **fourth-deadliest aviation** accident on American soil overall, excluding terrorism. • The **National Transportation Safety Board** cites poor communication between the **flight crew** as the probable cause of this accident, along with the **captain's poor decision-making on the non-precision approach.**
Colgan Air Flight 3407 (2009)	• **Colgan Air Flight 3407**, a **Bombardier Q400 operating as a Continental Connection flight**, crashed on February 12, 2009, in Clarence Center, New York, near Buffalo.

	• The **accident was caused by the pilots' failure to respond appropriately** to a **stall warning,** resulting in a loss of control and a subsequent impact with a house. 
AirAsia Flight 8501 (2014)	• **Indonesia AirAsia Flight 8501** was a scheduled international passenger flight operated by **Indonesia AirAsia from Surabaya, Java, Indonesia, to Singapore. On 28 December 2014, the Airbus A320-216** flying the route crashed into the **Java Sea**, killing all 162 of the people on board. • The **Indonesian National Transportation Safety Committee (KNKT or NTSC)** released a report concluding that a **non-critical malfunction** in the rudder control system prompted the captain to perform a **non-standard reset** of the on-board flight control computers. • **Control of the aircraft was subsequently** lost, resulting in a stall and uncontrolled descent into the sea.

	• **Miscommunication** between the two pilots was cited as a **contributing factor.** 

12. Enlist various institutions involved in aviation safety?

Institutions	Description
Directorate General of Civil Aviation	• The **Directorate General of Civil Aviation (DGCA)** is the **regulatory body** in the field of **Civil Aviation**, primarily dealing with safety issues. • It is **responsible for regulation of air transport services** to/from/within India and for enforcement of **civil air regulations, air safety, and airworthiness standards.** • The **DGCA also co-ordinates** all regulatory functions with the **International Civil Aviation Organisation (ICAO).**

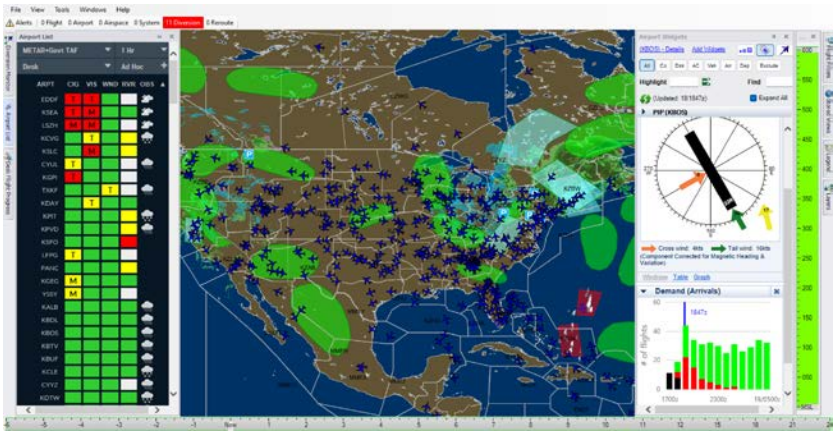
Airports Economic Regulatory Authority of India	• **Airports Economic Regulatory Authority of India (AERA)**, was established by the Government of India as a **statutory body of Government of India.** • The Parliament of India enacted an **Act called "The Airports Economic Regulatory Authority of India Act, 2008" .** • The said Act envisages the establishment of a statutory authority called the **Airports Economic Regulatory Authority** to regulate tariff for the **aeronautical services, determine other airport charges for services rendered at major airports and to monitor the performance standards of such airports.**
Bureau of Civil Aviation Security	• The **Bureau of Civil Aviation Security (BCAS)** was initially set up as a **Cell in the DGCA in January 1978** on the recommendation of the **Pande Committee.** • The BCAS was reorganized into an **independent department** under the **Ministry of Civil Aviation on 1st April, 1987.** • The main responsibilities of BCAS include **laying down standards and measures with respect to security of civil flights** at international and domestic airports in India.
Aircraft Accident Investigation Bureau	• **Section 7 of the Aircraft Act 1934** empowers the Government of India to make rules for **investigation of accidents** arising out of or in the course of the navigation in or over India of any **aircraft**, or **anywhere of aircraft registered in India**.

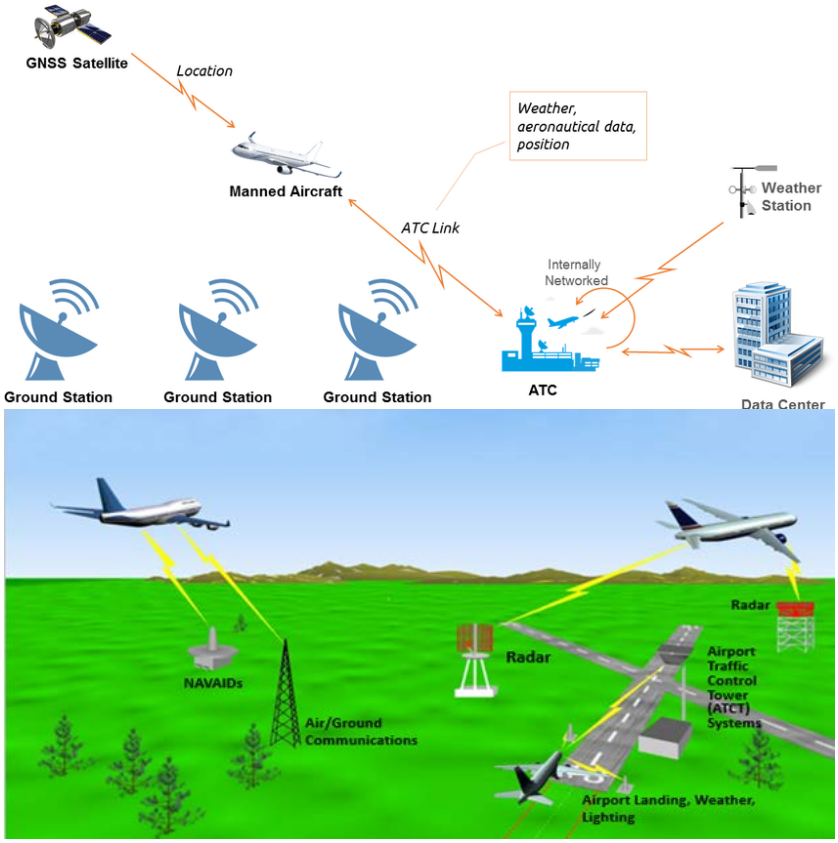
	• As per the Act and in conformity with **Article 26 of the Convention on International Civil Aviation**, earlier the Air **Safety Directorate of DGCA** was carrying out the **duties and responsibilities regarding investigation of aircraft accidents and incidents.** • This was governed by the **Aircraft Rules 1937.**
Airports Authority of India	• The **Airports Authority of India (AAI)** was formed on **1st April 1995** by merging the **International Airports Authority of India and the National Airports Authority** with a view to **accelerate the integrated development, expansion, and modernization of the operational, terminal and cargo facilities** at the airports in the country conforming to international standards.
Federal Aviation Administration (FAA)	• The **Federal Aviation Administration (FAA)** is the agency of the **United States Department of Transportation** responsible for the **regulation and oversight of civil aviation** within the U.S., as well as operation and development of the **National Airspace System.** Its primary mission is to ensure the **safety of civil aviation.** • The responsibilities of the FAA include: ▪ **Regulating civil aviation** to promote safety within the U.S. and abroad; ▪ **Encouraging and developing civil aeronautics**, including new aviation technology;

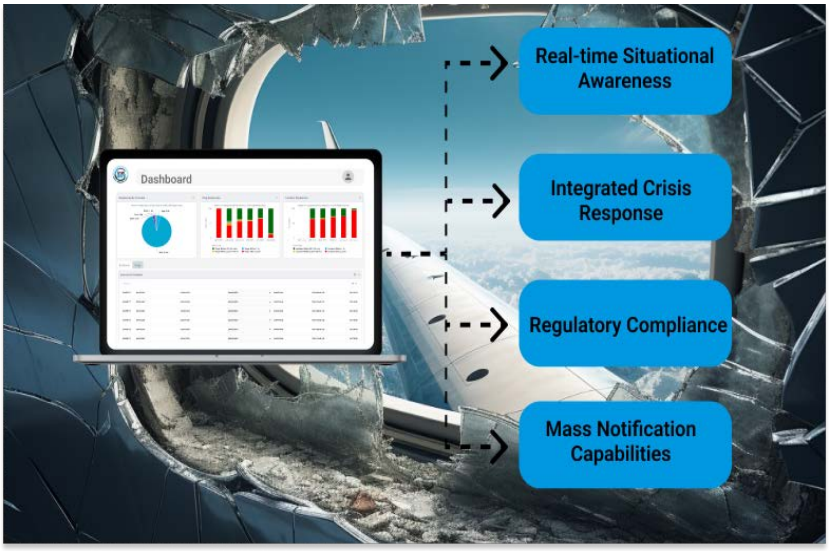
	▪ **Developing and operating a system** of air traffic **control and navigation** for both civil and military aircraft; ▪ **Researching and developing the National Airspace System** and **civil aeronautics.**
International Air Transport Association (IATA)	• An **international trade body** representing some **240 airlines comprising 94%** of scheduled **international air traffic.** • **IATA's** aim is to help airlines help **themselves by simplifying processes and increasing passenger convenience** while **reducing costs** and **improving efficiency.** • Safety is **IATA's number one priority**, and IATA's goal is to continually **improve safety standards, notably through IATA's Operational Safety Audit (IOSA).**
International Civil Aviation Organization (ICAO)	• The **constitution of ICAO** is the **Convention on International Civil Aviation**, drawn up by a conference in **Chicago in November and December 1944**, and to which each **ICAO Contracting State is a party.** • The **International Civil Aviation Organization (ICAO)** is a **United Nations agency** which helps **193 countries** to cooperate together and share their skies to their mutual benefit. • **ICAO** works in **close co-operation** with other members of the **United Nations family such as the World Meteorological Organization**, the **International Telecommunication Union, the**

	Universal Postal Union, the World Health Organization and the International Maritime Organization. 

13. What is the role of technology in the safety of the aviation sector?

Technology	Description
Weather Monitoring and Alert Software	• **Weather Monitoring and Alert Software** provides real-time weather data to pilots and **air traffic controllers**, aiding in informed **decision-making for flight planning** and safety measures, ultimately contributing to **enhanced safety protocols in aviation.** 

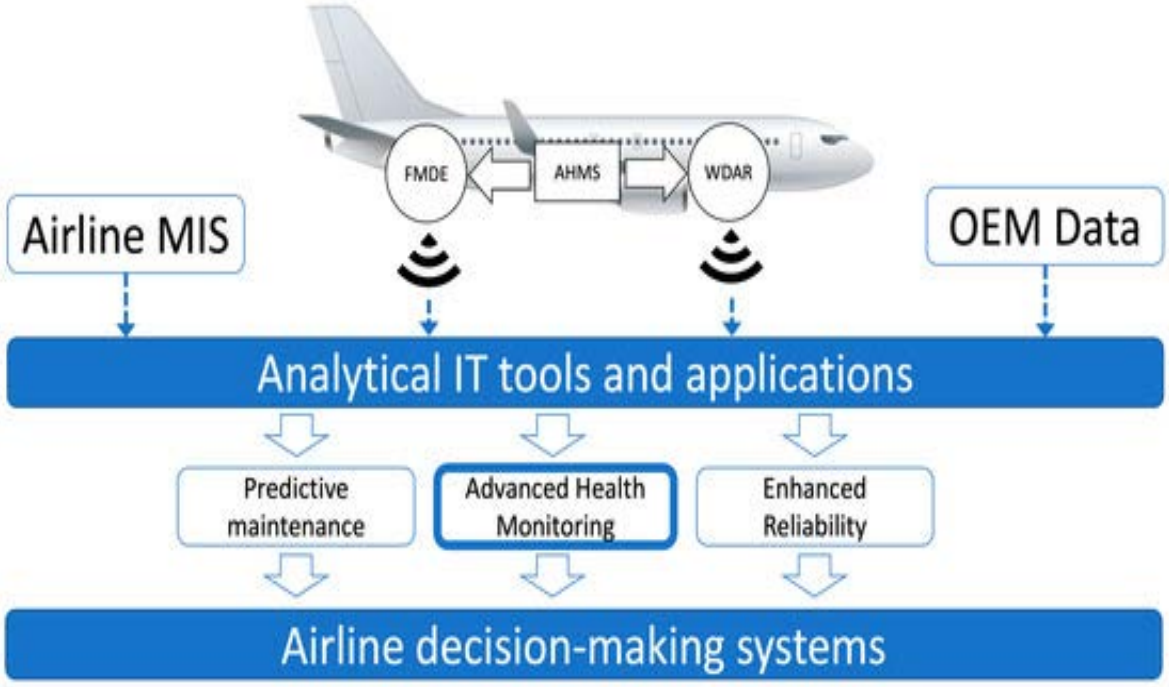
Air Traffic Management (ATM) Software	• **Air Traffic Management (ATM) Software** helps air traffic controllers manage and monitor **air traffic movements, ensuring safe and efficient operations** through features like **collision avoidance systems and airspace management tools.** 
Safety Management Systems (SMS) Software	• **Safety Management System** for airports oversees **safety-related activities, conducts risk assessments, and ensures compliance** with regulatory requirements, enhancing safety **culture and regulatory adherence within aviation organizations.**

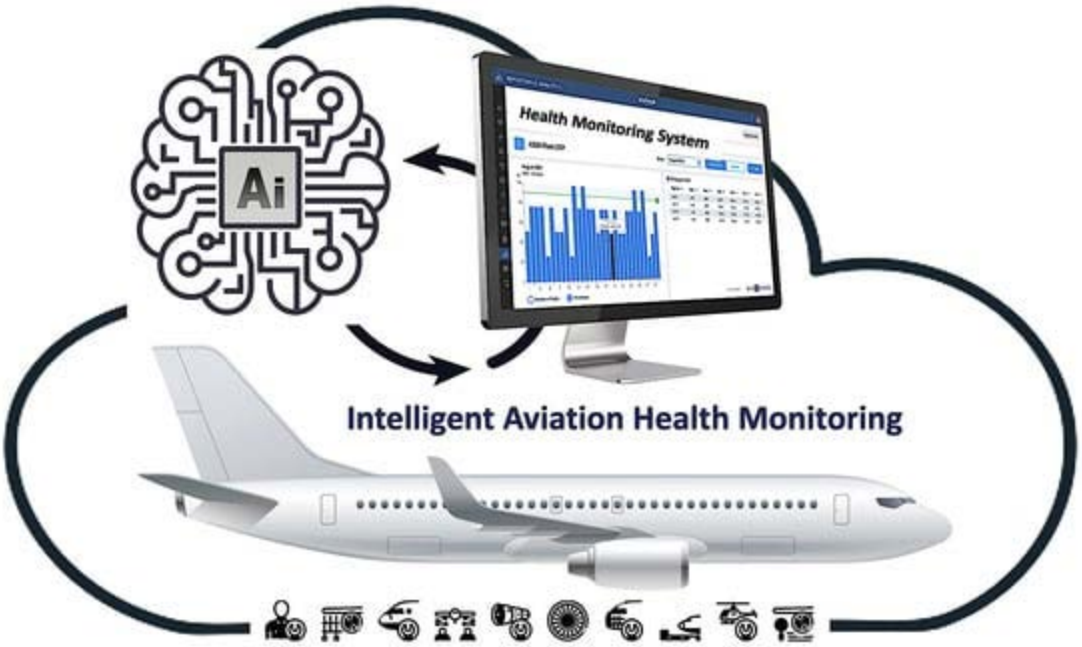
	
Crew Resource Management (CRM) Software	• **Crew Resource Management (CRM) Software** enhances **communication** and **decision-making** among flight crews, improving crew performance and contributing to a **safer aviation environment.**
Emergency Response Planning Software	• **Emergency Response Planning Software** aids in developing and implementing **emergency response plans**, ensuring swift and effective responses to various scenarios like **accidents and security threats.** 

Maintenance Tracking Software	• **Maintenance Tracking Software** manages aircraft maintenance activities, **reducing the risk of mechanical failures** and **ensuring regulatory compliance**, thus contributing significantly to overall flight safety.
Auto-pilot and auto-landing systems	• **Cockpit automation** is evolving with increasingly sophisticated **auto-pilot and auto-landing systems**, reducing pilot **workload and enhancing flight precision.**
Sustainable Aviation Fuels (SAF)	• **Sustainable Aviation Fuels (SAF)** are gaining a **foothold**, offering the prospect of a **green alternative to traditional jet fuels and reducing carbon emissions.**
Advanced materials	• **Advanced materials**, such as **lightweight carbon composites**, may make aircraft more **fuel-efficient and environmentally friendly.**
NextGen air traffic management	• **NextGen air traffic management** enhances **airspace efficiency** and safety with **satellite-based navigation and communication systems.**
Urban Air Mobility (UAM)	• **Urban Air Mobility (UAM)** is emerging, with **electric vertical take-off and landing (eVTOL) aircraft** aiming to transform urban transportation.
Hydrogen-powered aircraft	• **Hydrogen-powered aircraft** represent another potential path to **zero-emission aviation.**

14. How has automation revolutionized aviation maintenance and safety?

- **Automation uses computers and smart systems** to monitor and predict when parts of an aircraft need maintenance.
- This means issues can be spotted before they become big problems, **making flying safer.**
- **Automation** has also **improved safety** by helping pilots during flights.
- For instance, **autopilot systems can take over and guide** the plane in **emergencies**, reducing the chance of human error.
- The **aviation industry's transition** from manual to automated maintenance processes and the **integration of advanced technologies** like **autopilot systems** have **collectively elevated aviation safety to unprecedented levels**, ensuring smoother, more reliable, and safer flights for passengers worldwide.





15. How have we expanded the role of artificial intelligence (AI) in air travel?

- **AI-driven predictive maintenance systems** analyze vast amounts of **data from sensors and equipment on planes**, enabling airlines to predict when **components need servicing or replacement.**
- This **proactive approach** reduces the **risk of in-flight malfunctions, ensuring that aircraft are in optimal condition.**
- **AI** also assists pilots during flights by providing **real-time data analysis and predictive analytics.**
- Automated systems can **identify and address potential safety concerns**, such as **weather changes or navigation adjustments,** helping pilots make informed decisions and avoid dangerous situations.
- **AI-powered collision** avoidance systems can detect **nearby aircraft and obstacles**, issuing timely alerts to prevent accidents.
- AI contributes to **air safety through improved air traffic management.**
- **AI algorithms** help o**ptimize air traffic flow, reducing congestion** in the skies and minimizing the **risk of mid-air collisions.**

AI in Aviation	Description
Smart Cockpits and Autonomy	• The **integration of AI** in aviation is evident in the development of **smart cockpits and autonomous systems.** • **AI algorithms**, combined with advanced sensors and cameras, **enable aircrafts to perceive and respond** to their environment in real-time. • This **technology enhances pilot decision-making processes** and augments their capabilities, particularly in **challenging weather conditions** or complex airspaces.
Personalized Passenger Experiences	• **AI is revolutionizing** the passenger experience in a**viation, tailoring every aspect of the journey to individual preferences.** • **AI algorithms** analyze passenger data to offer **personalized in-flight entertainment** selections based on **past choices and preferences.**
Efficient Supply Chain Management	• Behind the scenes, **AI is optimizing supply chain management** in the aviation industry. • From **inventory management to logistics**, **AI algorithms** analyze historical data and predict future demands, **enabling airlines and manufacturers to streamline operations and reduce costs.** • **For instance, Airbus** has implemented an **AI-based system to optimize** its **supply chain and production process.**

	• This system **collects and analyzes vast** amounts of data from **various sources, including aircraft in operation** and **manufacturing processes**. • By doing so, the **AI system can predict** parts demand **more accurately, streamline inventory levels**, and reduce the risk of **overstocking or shortages.** • This has led to a **more efficient production flow and a reduction in delays for aircraft delivery**, ultimately contributing to **cost savings and increased customer satisfaction.**
Security and Fraud Detection	• In today's digital age, **where cybersecurity is a top priority**, AI is playing an **essential role in safeguarding aviation systems**. • **Advanced AI algorithms** are adept at detecting and thwarting **cyber threats, thus ensuring the integrity and security of critical aviation infrastructure**. • A notable example of **AI's efficacy** in **security was demonstrated** when an AI system at a **major international airport** identified a sophisticated **cyber-attack on its flight information control system**.
Fraud detection systems.	• **AI in aviation** is extensively used in **fraud detection systems.** • These **AI-driven cybersecurity systems** safeguard **financial transactions and prevent unauthorized** access to sensitive data, which is **paramount in an industry** handling vast amounts of **personal and financial information.**

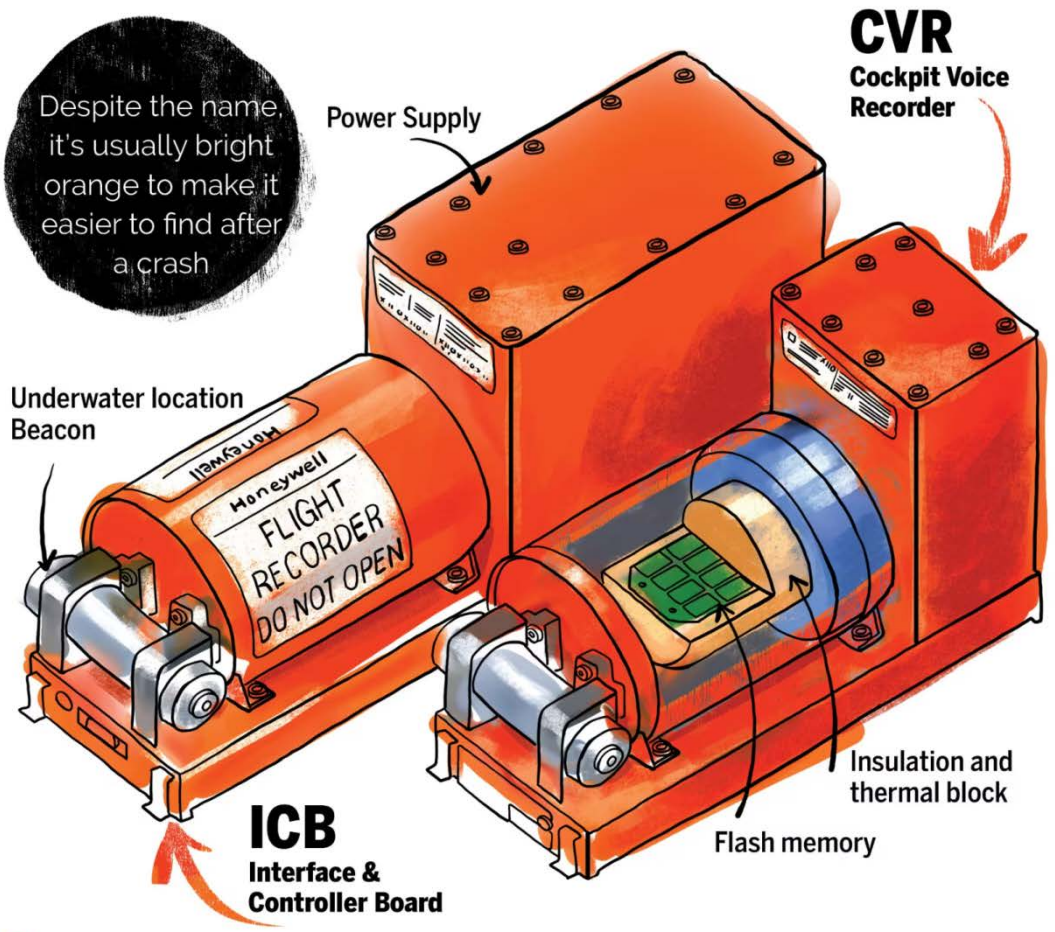
16. Mention about Airplane Safety Timeline?

17. What are Black Boxes?

- **Black boxes**, despite their name, are **bright orange or yellow flig**ht recorders installed in aircraft to **record flight data and cockpit audio.**
- **Black Box** was invented in **1954 by Australian scientist Dr. David Warren,** and became **mandatory in 1960.**
- A black box consists of **four main parts,** including an interface to facilitate recording and playback, underwater locator beacon, **"crash survivable memory unit"** to withstand a **force equivalent to 3,400 times the force of gravity** and the recording chip on a circuit board.
- The two black boxes of any aircraft are the **cockpit voice recorder (CVR) and the flight data recorder (FDR).**
- The **FDR logs critical technical parameters including altitude, speed, engine thrust,** and flight path data.
- The **CVR captures all cockpit audio - pilot conversations, radio transmissions, warning alarms**, and ambient mechanical sounds.

Black Box

A black box in aviation refers to a pair of flight recorders that capture key flight information. They are critical for investigations following an aircraft crash



Built to survive extreme conditions, black boxes can endure forces up to **3,400 Gs**, temperatures reaching **1,100°C**, and transmit signals every second from depths of up to **19,000** feet for as long as 30 days

18. What is the history of Black Box?

Year	Description
1950	• The **first generation of Flight Data Recorders** (FDRs) emerged with **metal foil as the recording medium.**

1953	• **General Mills sold the first FDR** to **Lockheed Aircraft Company**, enclosed in a yellow-painted spherical shell.
1954	• **Australia's David Ronald de Mey Warren invented the world's first FDR while probing** an air crash. • In 1953, **Warren, a jet fuel expert, was working as part of a special team analysing** mysterious mid-air explosions experienced by the **world's first commercial jet aircraft, the de Havilland Comet.** • Subsequently, he invented the FDR so that the recordings would be helpful in the analysis of aircraft accidents.
1960	• **FDRs and CVRs are made mandatory for aircraft.**
1965	• **FDRs** were required to be **painted bright orange or yellow to locate them easily at crash sites.**
1990	• **Solid-state memory devices replaced magnetic tapes in FDRs.** • According to the **International Civil Aviation Organization (ICAO),** audio recordings from **cockpit voice recorders** supplement flight data by providing related details on flight crew responses. • The recordings also aid in assessments of **how radio communications or other outside distraction**s may have been a factor in an accident. • Their data has **assisted investigators' understanding of how aircraft perform**, both before and during an accident or incident, and **provided useful information for airline flight data analysis programmes**, as per ICAO.

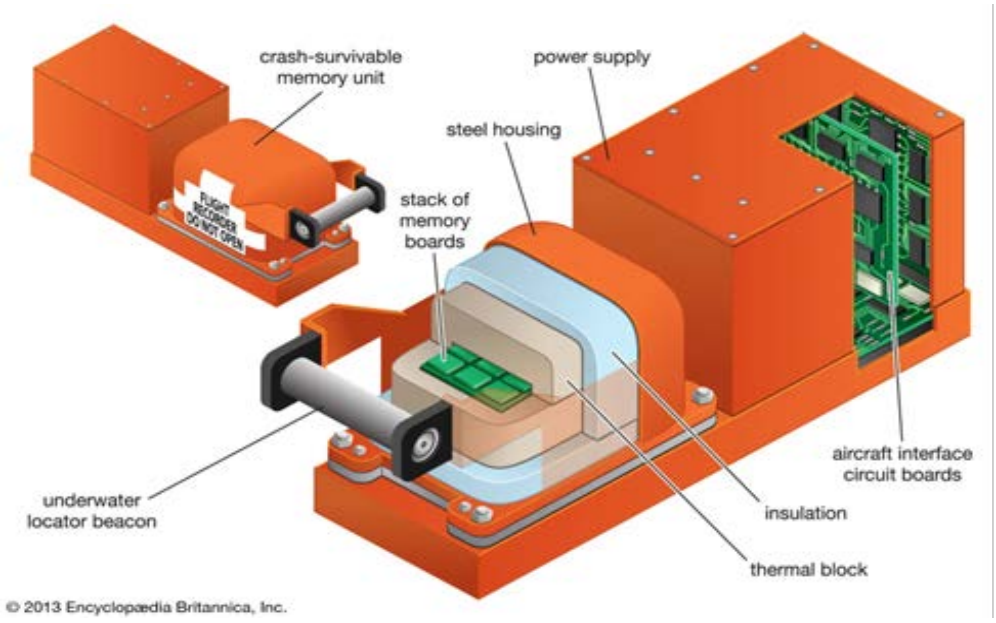
19. Why is it called black box?

- According to the **Airbus website**, before **Warren**, **French engineer François Hussenot** began working on a **data recorder in the 1930s**.
- This equipment had sensors that would optically project around **10 parameters onto a photographic film.**
- This **film ran continuously in a box** that was constructed to **prevent any light** from entering it.
- Hence, it was called a **"black box".**

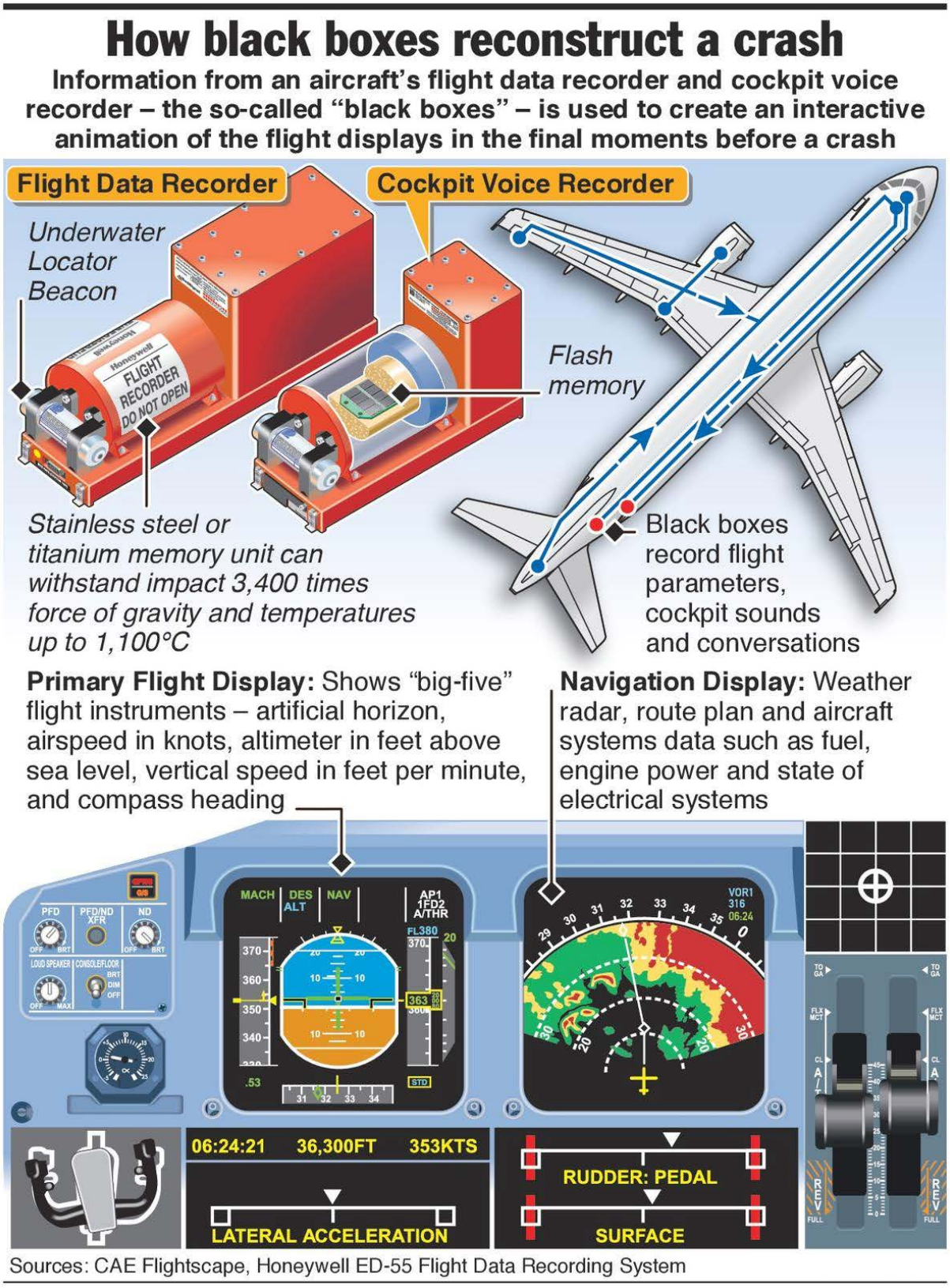
20. How Does the Black Box Survive Crashes?

- **Black Boxes** are built to **withstand incredibly harsh conditions.**
- They are encased in a **strong titanium or stainless-steel shell** and insulated to resist **extreme heat and pressure.**
- **Key features include:**

Key Features	Description
Fire Resistance	• The **Black Box** can survive temperatures up to **1,100°C (2,000°F) for at least 60 minutes.**
Impact Resistance	• It is built to **withstand impacts** of up to **3,400 Gs (the force of 3,400 times the pull of gravity).**
Waterproofing	• It can stay **submerged in water** as deep as **6,000 meters (about 20,000 feet) for 30 days** without losing data.
Underwater locator beacons (ULBs)	• **Black Boxes** are equipped with **underwater locator beacons (ULBs)**, which **send out signals** to help **search teams** locate them in a **water crash.**



21. How do Black Box help in investigation?



22. Mention about whistleblower's Boeing safety claims?

- **John Barnett** was a former **quality manager** who **flagged safety lapses** in the **Boeing Dreamliner programme** before his **mysterious death in 2024.**
- At the **North Charleston** plant between **2010 and 2017**, **Mr Barnett raised red flags** about what he described as a **steady decline in safety protocols.**
- He said that **tiny metal shavings were left near important wires,** which could **cause dangerous problems mid-flight**.
- He also claimed that about **one in four oxygen masks might not work** in an emergency.
- He also said **some parts were** missing or **not properly recorded** during the building process, showing poor safety checks.

- In **2017**, he filed **formal complaints with the Federal Aviation Administration (FAA)** and the **Occupational Safety and Health Administration (OSHA).**
- The **FAA did confirm certain issues** he highlighted and **instructed Boeing to fix them.**
- In **2019, John Barnett went public** with his allegations in media interviews. He was later **featured in the 2022 Netflix documentary 'Downfall: The Case Against Boeing',** which examined the company's safety culture, particularly after the **737 MAX disasters.**

23. What is the relevance of the topic for UPSC CSE?

GS Paper - 2

- Important International Institutions
- Government Policies & Interventions

Some questions from this year and previous years interview transcripts.

Board Suman Sharma mam:

- If we divide aviation between civil and military, which one should we focus on given recent deals?

Board Suman Sharma mam:

- How does the Civil aviation sector impact tourism?

Board Dinesh Dasa sir:

- Why do new airlines fail in the aviation market?

Board RN Choubey sir:

- Tell me something about the aviation sector.

Some questions for QUIZ.

Q1. The Chicago Convention is related to which of the following:

(a) Women safety
(b) Road Accidents
(c) Cyber security
(d) Aviation rules and safety

Ans: (d)

Some questions for POLL.

Q1. Do you think Boeing compromises on safety standards of aircraft?

(a) YES
(b) NO
(c) Can't say.

Q2. Do you think Airbus is more safe than Boeing?

(a) YES
(b) NO
(c) Can't say.

■■■■