Air Crashes Analysis

Project Overview: This project involves a comprehensive analysis of global air crash incidents spanning over a century (from 1908 to 2024) as a capstone requirement for certification at HIIT.

Objective: The primary objective is to transform a large-scale historical dataset into actionable safety insights using Excel and data analysis techniques.

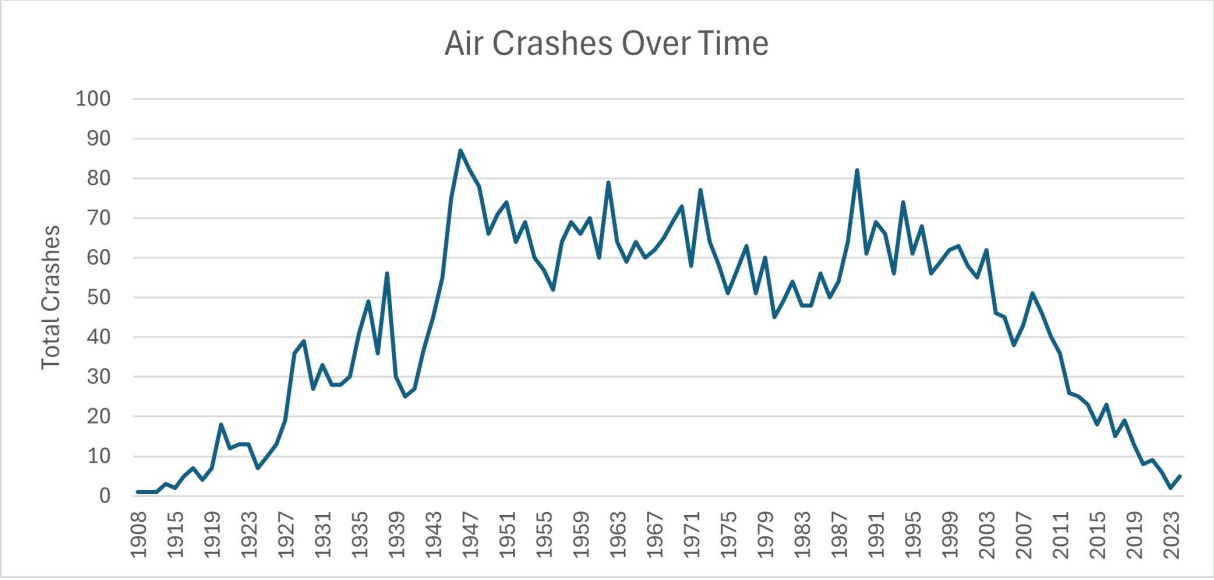
Dataset Source: Air Crashes Full Dataset from Kaggle by Jonathan Ogwumike. click here to view

Data Cleaning and Transformation:

- Standardized different names for distinct countries across the Country column.
- Replaced ambiguous and unknown values in the Country column to their proper names using relative data from the Crash Location column.
- Standardized values in the Aircraft Manufacturer column using the first words from relative values in the Aircraft column as an aircraft's first name is typically the name of it's manufacturer.
- Trimmed values in the Aircraft Model column in order to get rid of unwanted artifacts.
- Reversed the order of words in the Operator column to properly represent operator names.
- Renamed columns to properly describe their values.
- Converted columns to their respective data types.
- Unified Year, Quarter and Month columns into Date column.
- Created Continent column based on values in the Country column.
- Created Domain column to classify flights into Civilian or Military flights.
- Calculated Total Fatalities by summing values of Air Fatalities and Ground Casualties.
- Calculated Survival Rate through the ratio of Souls Aboard and Air Fatalities and represented in percentage.

Research Questions:

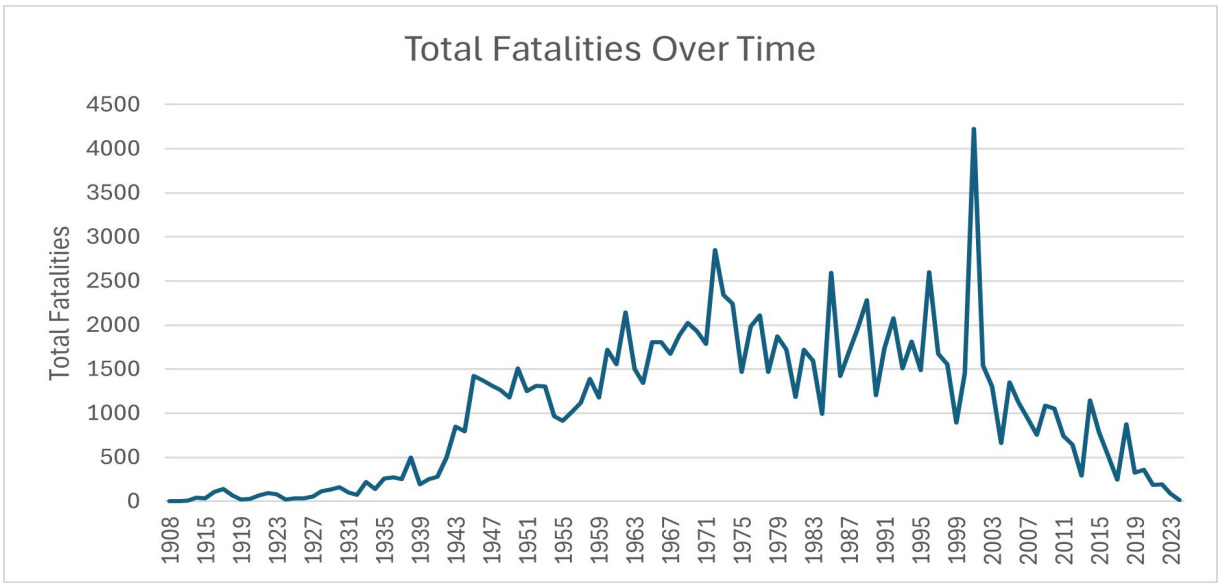
1. **What is the yearly trend of air crashes from 1908 to 2024**?



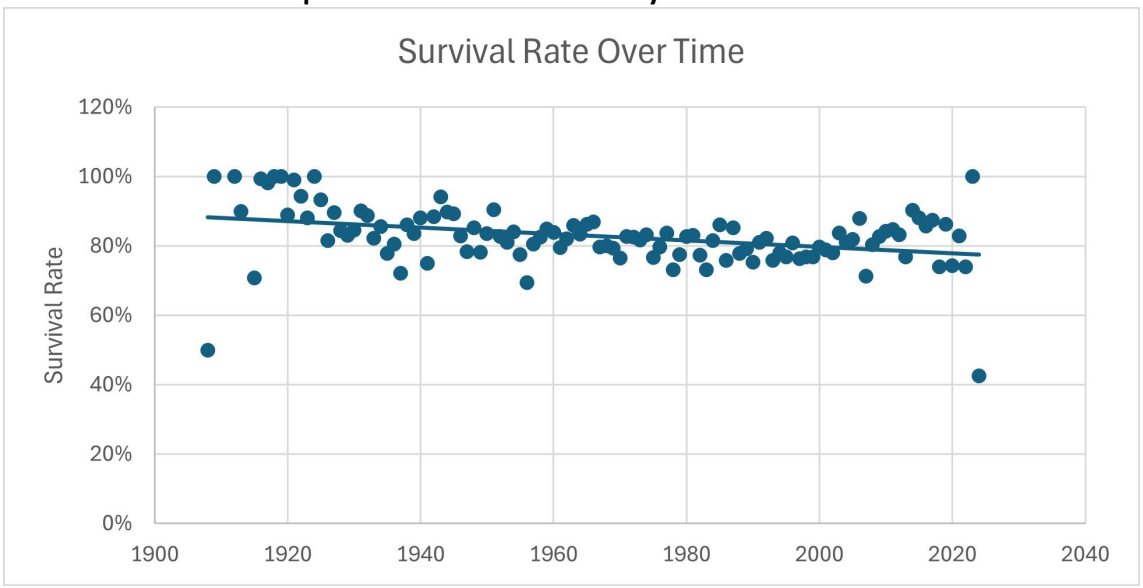
Air Crashes saw steady growth from 0 to nearly 90 per year in the 1940s (during the height of WWII). Crashes have been on a steady decline ever since with incidents dropping to under 50 per year since the 2010s. This reflects improvements in air travel safety due to innovations and improved regulations.

2. **How has total fatalities evolved over time**?

Similar to the trend of crashes over the years, total fatalities (air fatalities and ground casualties) saw a steady rise from 0 into the thousands yearly after 1944. Total fatalities have been on the decline in recent times with total yearly fatalities dropping below the thousands in 2015.
It is worth noting the spike in 2001 which is majorly contributed by the fatalities of the September 11 attacks by the terrorist group Al-Qaeda in the United States. It represents the highest fatality in aviation history with almost 4,000 recorded fatalities.

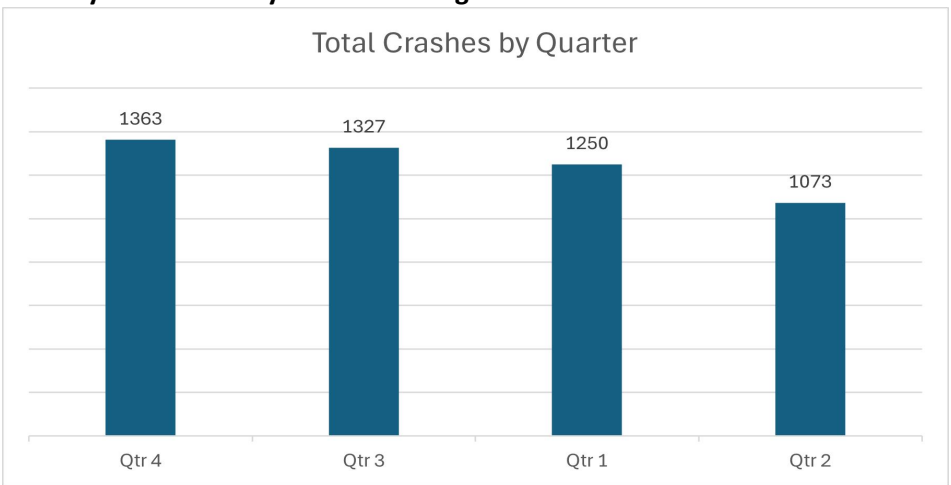


3. Has the overall survival rate improved or declined over the years?



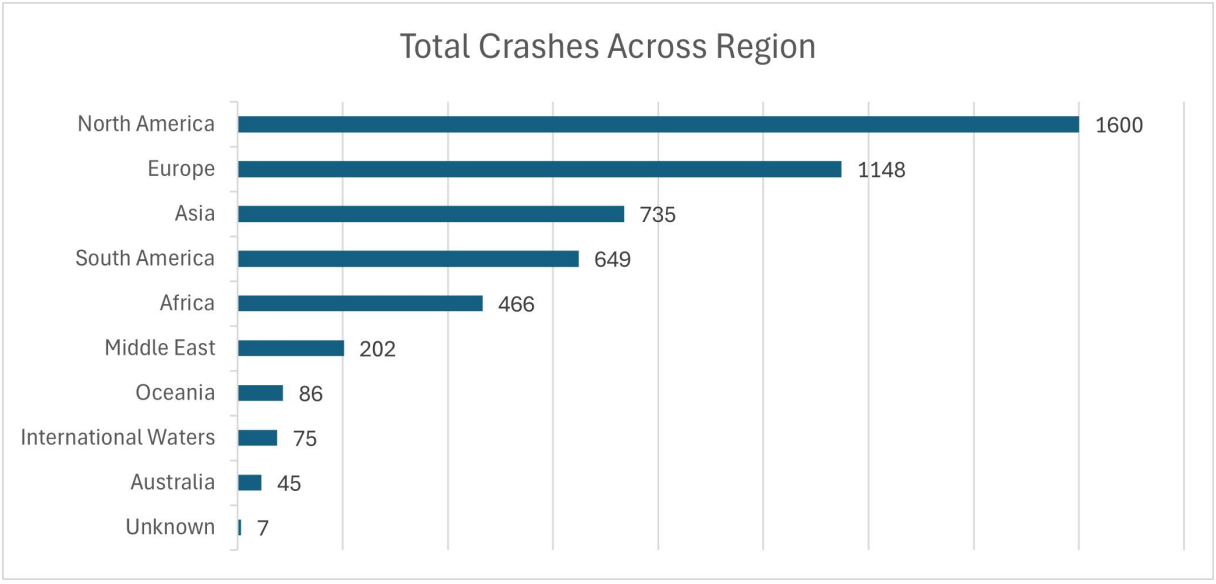
Survival rate over the years has seen a shallow decline from over 80% to a little under 80%. While it's not substantial, the chart does highlight a decline in survival rate over the years, this can be attributed to the increase in passenger volume and the high risk nature of plane crashes.
While fewer crashes happen today, modern planes are much larger therefore when a rare crash *does* happen, the higher passenger density slightly skews the overall survival percentage downward.

4. Which Quarter of the year historically records the highest number of incidents?



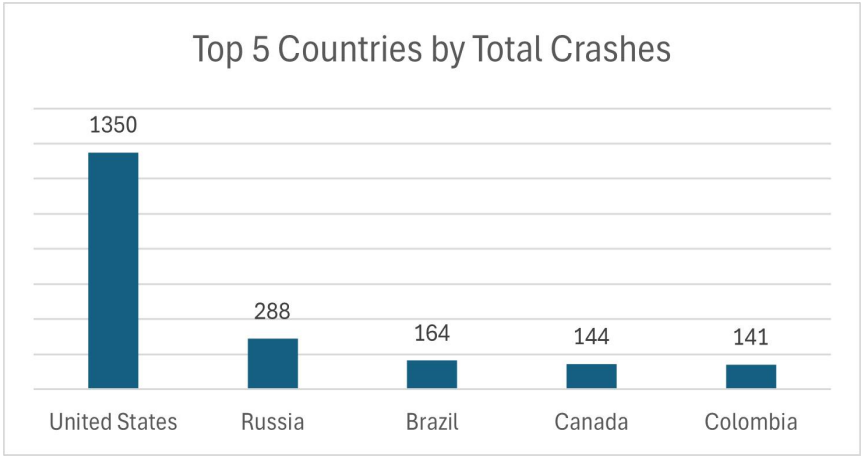
The dataset shows the highest number of crashes happen in Q4 and closely followed by Q3. This suggests that most crashes happen during the second half of the year.

5. Which Region has the highest frequency of air crash incidents?



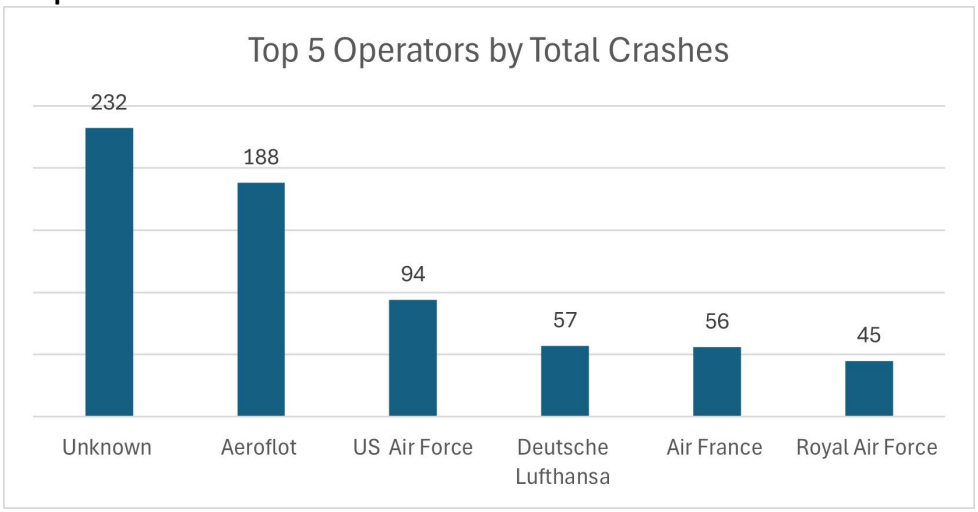
North America records the highest frequency of crash incidents. This correlates with the fact that North America is one of the earliest and biggest players in aviation and they have deeply rooted presence/impact in aviation ever since. North America, Europe and Asia account for nearly 50% of all crashes, this aligns with the world percentage of air travel traffic where North America, Asia and Europe are the top three. This suggests a correlation between air traffic and crash rate.

6. What are the Top 5 Countries with the most recorded crashes?



United States records the most crashes in aviation history at roughly 27% of all crashes, significantly more than any single nation on the planet.

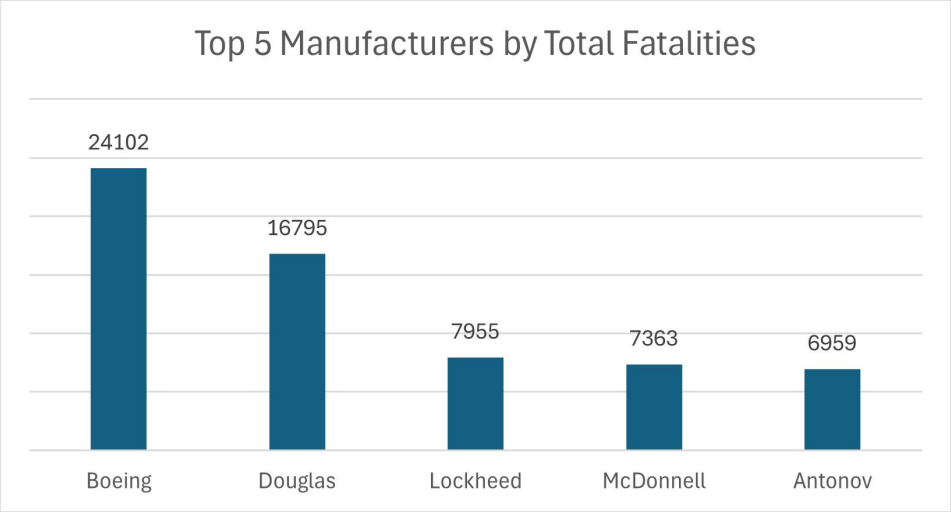
7. Who are the Top 5 Operators with the most incidents in the dataset?



Avoiding the Unknowns, Aeroflot (Russia's largest airline) records the most crashes, at 2x that of the top 2 (US Air Force).

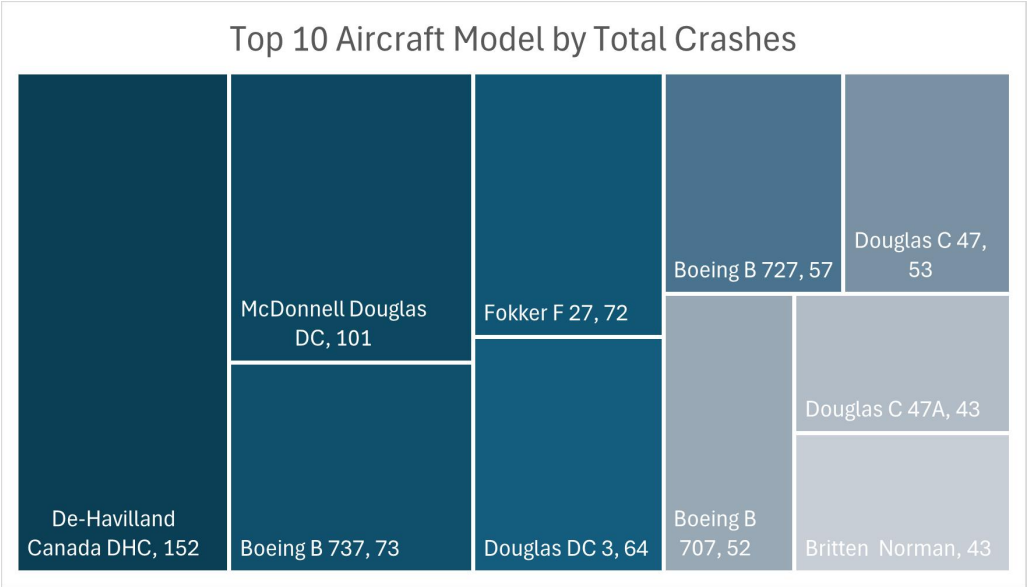
It is worth noting the fact that each of the represented operators have millions of successful flight operations in their belt, which makes their crash record only a tiny fraction of their entire flights. This serves as a testament to the impressive safety record of air travel.

8. Which Aircraft Manufacturer is associated with the highest number of fatalities?



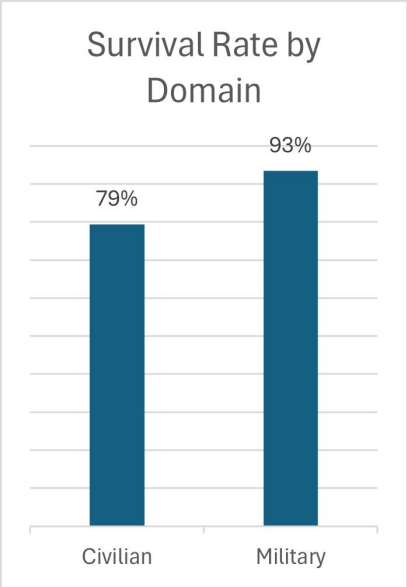
Boeing records the highest number of total fatalities in aviation history at over 24k souls.
It is worth noting that the top 5 manufacturers are some of the earliest aircraft manufacturers to serve commercial air travel and have transported a lot of passengers over time, suggesting a correlation between number of passengers transported and time in the industry with total fatalities.
Of course, safety in aviation is more than just time in the industry and number of passengers transported.

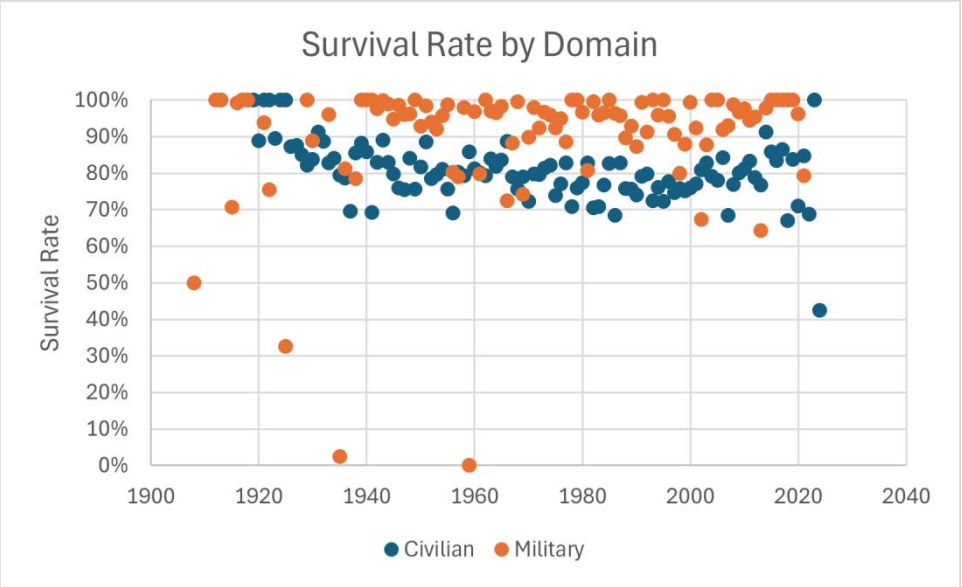
9. Are certain Aircraft Models more prone to accidents than others?



The aircraft models represented are models introduced and manufactured during the early days of the jet age with some models still in production to this day in form of improved versions while others are retired.
The data seems to point towards the idea that older aircraft models are less reliable as they record some of the most crashes but it is worth noting that some of these aircraft's operation parameters were less forgiving, some operated in more risky environments, some operated in times when safety regulations and technologies were still in their early days but their combined shortcoming has led to the improved safety in current aviation. It's worth being aware of the nuance.

10. How does the survival rate compare between Military and Civilian flights?
Military flights have a higher survival rate compared to civilian flights despite the riskier nature of military flight operations. This is likely due to some improved safety features of military flights like the use of ejection seats and the reduced number of souls aboard a typical military flight.
It is worth noting that military flights have recorded some of the most dire survival rates in aviation history (as represented on the scatter plot).





Conclusion: The analysis highlights the evolution of air crashes over the years, from the earlier days of risky expeditious flights to the commercial and military adoption of air travel. The analysis shows that while air travel is inherently risky when a crash does happen due to the extreme circumstances that govern air travel, safety in air travel has increased substantially over the years especially in recent years with less than 20 recorded crashes a year since 2010.
The analysis also highlights the safety in airplanes as more recent airplanes have fewer crash records, this can be attributed to the result that improved safety regulations and technologies have had on air travel.

Recommendations: Increased effort and investment in upcoming and promising technologies to help improve the survival rate in the event of a crash is highly recommended. Such technologies are listed below.

- Fuselage Cocoon Airbags (Project REBIRTH): This project is a technology that aims to include external airbags housed in the nose, belly, and tail of the aircraft. In the event of an unavoidable crash, AI detects the descent profile and deploys these airbags to "cocoon" the fuselage, absorbing the massive impact energy that usually destroys the cabin. Read more here
- Morphing Wing Technology: Instead of using rigid flaps and slats, these wings can seamlessly change their physical shape (camber and twist) in real-time, similar to a bird's wing. NASA and Airbus have been flight-testing prototypes. Read more here
- Autonomous Emergency Landing Systems: Already certified for smaller jets (like the Cirrus Vision Jet), this technology is being scaled for larger commercial liners. If the pilots become incapacitated, passengers or crew can press a dedicated button which activates a system that uses AI to communicate with Air Traffic Control, navigates around weather, lowers the landing gear, and lands the plane autonomously. Read more here
- EASA Part-AI Certification Standards: The adoption of the European Union Aviation Safety Agency's (EASA) new roadmap for certifying Artificial Intelligence. Currently, we don't have a global standard for how safe an AI pilot needs to be. This regulation establishes the trustworthiness levels required to let AI take control during emergencies. Read more here
- Space Traffic Management (STM) Integration: As commercial space launches become daily events, they share airspace with airliners. New regulations are being drafted to integrate Space Traffic into standard Air Traffic Control to prevent high-altitude collisions between airliners and launch debris, a rapidly emerging risk category. Read more here