Visualizing Civil Aviation Accidents: A Data-Driven Analysis

IT642 Interactive Data Visualization

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1 Introduction

Aviation safety has evolved tremendously since the first powered flight over a century ago. Modern aircraft are now equipped with advanced safety systems, and flight crews undergo extensive training. Nevertheless, learning from past incidents remains essential to prevent similar accidents in the future. The NTSB Aviation Accident Database provides an invaluable resource, documenting aviation accidents with comprehensive details that enable deeper insights into contemporary aviation safety trends and challenges.

The National Transportation Safety Board (NTSB) database includes extensive data on civil aviation accidents and select incidents that occurred within the United States, its territories, and international waters. Although this dataset contains records dating back to 1962, our analysis focuses on data from 2008 onward. This choice ensures that our insights reflect recent trends and address current safety issues, particularly as new technologies and operational procedures have been integrated into aviation. Every entry in the database includes critical details such as the date and location of each accident, aircraft type and class, incident severity, weather conditions, injury specifics, and a thorough analysis of probable causes and contributing factors.

This detailed, recent dataset forms a valuable resource for research into modern aviation safety. By systematically examining the 2008-forward records, we aim to identify patterns and trends that can guide ongoing safety initiatives and influence policy-making decisions. The insights derived from this focused, contemporary dataset allow for a meaningful understanding of current challenges and help inform efforts to enhance safety in an evolving aviation landscape.

2 Project Goals And Objectives

2.1 Project Goal

The aim of this project is to carry out an in-depth analysis of aircraft accident data for possible patterns and correlations that might contribute to the cause or seriousness of an accident. Projected analyses into such factors as aircraft make, model, type of engine, flight phase, and even other weather conditions should therefore improve our understanding of the key risk factors in aviation. Last, results from these studies would have the capability to provide general conclusions that may aid in giving actionable insights into safety improvements and risk mitigation strategies for the aviation industry.

2.2 Project Objectives

2.2.1 Analyze Aircraft Categories and Their Accident Rates:

- Determine whether specific aircraft types (e.g., airplanes vs. helicopters) or models are associated with higher accident rates.
- Evaluate the influence of engine types, including single vs. multi-engine, on accident likelihood.

2.2.2 Assess Weather Conditions and Their Impact on Accident Severity:

- Investigate how weather conditions (VMC vs. IMC) affect the frequency and severity of accidents, testing the hypothesis that adverse conditions increase accident rates.

2.2.3 Examine Flight Phases and Accident Occurrence:

- Analyze which phases of flight, such as landing or takeoff, are associated with higher accident rates, supporting the hypothesis that critical phases have increased operational risks.

2.2.4 Evaluate Injury Outcomes Based on Aircraft Characteristics:

- Explore the relationship between injury severity (fatal vs. non-fatal) and factors like aircraft make, model, and engine type, to identify any patterns associated with more severe outcomes.

2.2.5 Synthesize Findings to Develop Recommendations:

- Based on the analysis, provide insights and recommendations aimed at improving safety, focusing on high-risk factors and accident-prone conditions identified throughout the study.

2.3 What our Story aims to Convey?

This report will walk readers through a journey of identifying aviation risk factors, highlighting critical areas for safety improvements. The analysis will systematically address questions around aircraft type, weather conditions, flight phase, and injury outcomes, providing a clear path from data exploration to actionable conclusions. Through this narrative, we aim to pinpoint key trends and present strategies for enhancing aviation safety.

3 Dataset Description

The dataset consists of multiple data files sourced from the National Transportation Safety Board (NTSB) portal. These files provide extensive information about aviation accidents and incidents, including details about the events, aircraft characteristics, flight phases, weather conditions, and injury outcomes. The primary files and their key variables are as follows:

3.1 Events Data (events.csv)

Contains details about individual accident events, such as:

- Event Information: `ev_id`, `ev_date`, `ev_time`, `ev_city`, `ev_state`, `ev_country`
- Weather and Visibility: `light_cond`, `sky_cond_nonceil`, `vis_sm`, `wind_dir_deg`, `wx_temp`, `wx_cond_basic`
- Injury Counts: `inj_tot_f` (fatal injuries), `inj_tot_m` (minor injuries), `inj_tot_n` (no injuries), `inj_tot_s` (serious injuries), `inj_tot_t` (total injuries)
- Aircraft Information: `mid_air`, `on_ground_collision`, `apt_name`, `latitude`, `longitude`

This file provides data crucial for analyzing accident locations, timing, weather impact, and injury severity.

3.2 Aircraft Category Data (cat.csv)

Contains details on the types and categories of aircraft involved in events:

- Aircraft Information: `acft_category` (category of the aircraft), `acft_make`, `acft_model`

- Registration Information: `homebuilt`, `oper_name`
- Event Link: `Ev Id` (linking to the events.csv file)

This data is useful for assessing which aircraft types and makes are more prone to accidents.

3.3 Aviation Data (AviationData.csv)

This is a comprehensive dataset that captures detailed accident-specific information, including:

- Event and Location: `Event.Id`, `Location`, `Airport.Code`, `Airport.Name`
- Injury Severity: `Injury.Severity` (categorizing accidents as fatal or non-fatal), `Total.Fatal.Injuries`, `Total.Serious.Injuries`, `Total.Minor.Injuries`
- Aircraft Details: `Make`, `Model`, `Number.of.Engines`, `Engine.Type`, `Aircraft.damage`
- Flight Phase and Weather: `Broad.phase.of.flight`, `Weather.Condition`

This file enables in-depth analysis of injury outcomes, aircraft damage levels, and the role of weather and flight phase in accidents.

3.4 Occurrences Data (occurrences.csv)

Describes specific occurrences within each event, providing detailed insights into the flight phases and circumstances of the accident:

- Event Link: `ev_id` (linking to events.csv and AviationData.csv)
- Occurrence Details: `Occurrence_Code`, `Phase_of_Flight`, `Altitude`

Useful for evaluating high-risk flight phases and recurring occurrences during incidents.

3.5 Codes Data (codes.csv)

Contains encoded information, including:

- State Codes: Mappings of US states to codes to facilitate regional analysis.

3.6 Calculated Fields

To enhance insights from the raw dataset, I created two calculated fields in Tableau, designed to categorize accidents by their severity and to help quantify the impact of these incidents:

1. High Consequence:

   - Formula: IF [Inj Tot F] + [Inj Tot S] ¿ 0 THEN "YES" ELSE "NO" END
   - Purpose: This field identifies accidents classified as "High Consequence" based on the severity of injuries. If there is at least one fatal (Inj Tot F) or serious (Inj Tot S) injury, the accident is labeled as "High Consequence." This allows for focused analysis on incidents with significant injury outcomes, aiding in understanding patterns associated with more severe accidents.

2. Percent High Consequence:

   - Formula: SUM([High Consequence Count]) / COUNT([State]) * 100
   - Purpose: This field calculates the percentage of high-consequence accidents per state. It helps to quantify the relative impact of high-consequence incidents across different regions, providing a comparable measure of risk. By calculating this percentage, I can visualize the concentration of severe accidents geographically, identifying states with higher relative incident severity.

4 Context And Problem Statement

4.1 Context

The NTSB Aviation Accident Database (2008-present) provides comprehensive data about civil aviation accidents across the United States. The visualizations focus on geographical distribution of accidents, aircraft categories, and accident intensities across different states, offering insights into modern aviation safety patterns.

4.2 Problem Statement

- Understanding Risk Factors: Identifying the most common factors contributing to accidents (e.g., weather conditions, aircraft type, phase of flight).
- Aircraft Safety: Determining if certain aircraft makers or models are involved in more accidents than others.
- Weather Impact: Assessing the role of weather conditions (VMC, IMC) in accident severity and frequency.
- Flight Phase Risk: Examining the broad phase of flight (landing, takeoff, etc.) to understand where most accidents occur.

- Injury Severity: Understanding the correlation between aircraft type and injury outcomes (fatal, non-fatal).

4.3 Questions

- What US states have witnessed the most amount of accidents?;
- How have accidents trended over time?;
- Is there any seasonal trend in accident rates?-During what phase of flight do most accidents occur?;
- What was the purpose of flight for most accidents?;
- Fatality rates in amateur built aircraft compared to professionally built aircraft?;
- What are the most common causes for accidents?
- Is there a particular category of aircraft more prone to accidents (e.g., airplanes vs. helicopters)?
- How do weather conditions like VMC and IMC impact accident rates?
- What is the impact of aircraft make on flight safety? (e.g., Cessna vs. Piper)
- Is there a significant correlation between the broad phase (landing, takeoff) and the occurrence of accidents?
- What is the correlation between engine type (reciprocating, turbofan, etc.) and accident severity?

- Does aircraft model have any influence on accident rates or injury outcomes?

4.4 Hypothesis

- **Hypothesis 1**: Aircraft operating in landing or takeoff phases are more prone to accidents due to higher operational risks in these phases'
- **Hypothesis 2**: Accidents are more frequent in adverse weather conditions (IMC) than in clear weather (VMC).
- **Hypothesis 3**: States with higher aviation activity (like California and Texas) will show higher accident concentrations.

5 Insights To Each dashboard

Interpret the results obtained. Compare them with theoretical values, explain discrepancies, and discuss their significance.

5.1 Overview

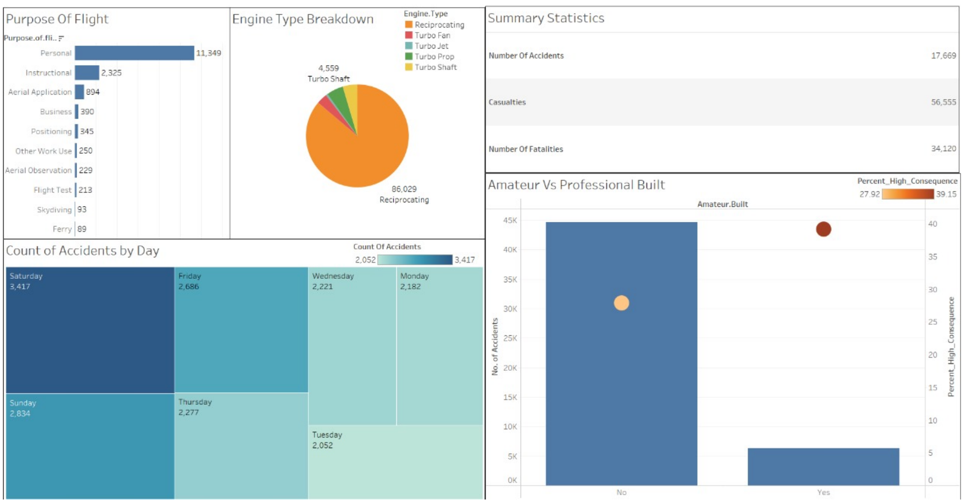

Figure 1: Dashboard Of Overview

5.1.1 Purpose of Flight (Bar Chart)

Marks and Channels:

- **Marks**: Line
- **Channels**:
  - **X-position** (Quantitative): Represents the number of accidents.

  - **Y-position** (Categorical): Shows different flight purposes.

Rationale:

- Horizontal bars effectively show comparisons across categories.
- Clear ranking of flight purposes.
- Easy-to-read labels and values.
- Efficient use of space for displaying few categories.

5.1.2 Engine Type Breakdown (Pie Chart)

Marks and Channels:

- **Marks**: Area
- **Channels**:
  - **Size** (Quantitative): Shows the proportion of each engine type.
  - **Color** (Categorical): Differentiates between engine types.

Rationale:

- Effectively shows part-to-whole relationships.
- Distinct colors help differentiate engine types.
- Size of sectors immediately conveys dominance of reciprocating engines.
- Useful for illustrating proportional distribution.

5.1.3 Count of Accidents by Day (Tree map)

Marks and Channels:

- **Marks**: Area
- **Channels**:
  - **Size** (Quantitative): Represents the number of accidents.
  - **Color Gradient**: Distinguishes between days.

Rationale:

- Color variations help differentiate days.
- Area size is proportional to accident count.
- Efficient use of space while maintaining readability.

5.1.4 Amateur vs Professional Built (Bar Chart with Overlay)

Marks and Channels:

- **Marks**: Lines and Points
- **Channels**:
  - **Y-position** (Quantitative): Number of accidents.
  - **X-position** (Categorical): Amateur vs. professional.
  - **Color**: Indicates percentage scale.
  - **Secondary Axis**: Represents percentage.

Rationale:

- Dual-axis presentation shows both count and percentage.
- Clear comparison between amateur and professional categories.
- Color gradient adds an additional dimension of information.
- Effective for displaying multiple related metrics.

5.1.5 Summary Statistics (Text Display)

Rationale:

- Provides a clear presentation of key metrics.
- Easy to read and understand.
- Offers essential context for interpreting other visualizations.
- Efficient use of space for numerical data.

Insights:

- Most of the accidents have occurred in personal flight purpose as most of the flights are taken by people for personal purposes.
- The heatmap indicates that Saturday has the highest number of accidents, followed by Sunday and Friday, suggesting a possible increase in flight activities or less stringent operational controls during weekends.
- We can also see that the percentage of high consequence accidents is much higher for amateur built aircraft than non-amateur built aircraft. It seems that the chances of surviving a crash in an amateur built aircraft is lower than a non-amateur built

aircraft. Its likely this is related to the inherent risks of flying an aircraft that was built by a hobbyist rather than a certified engineer.

- Most of the accidents have occurred in reciprocating engine type as it is one of the common type of engines for general aviation, light aircraft, and some helicopters

5.2 Weather

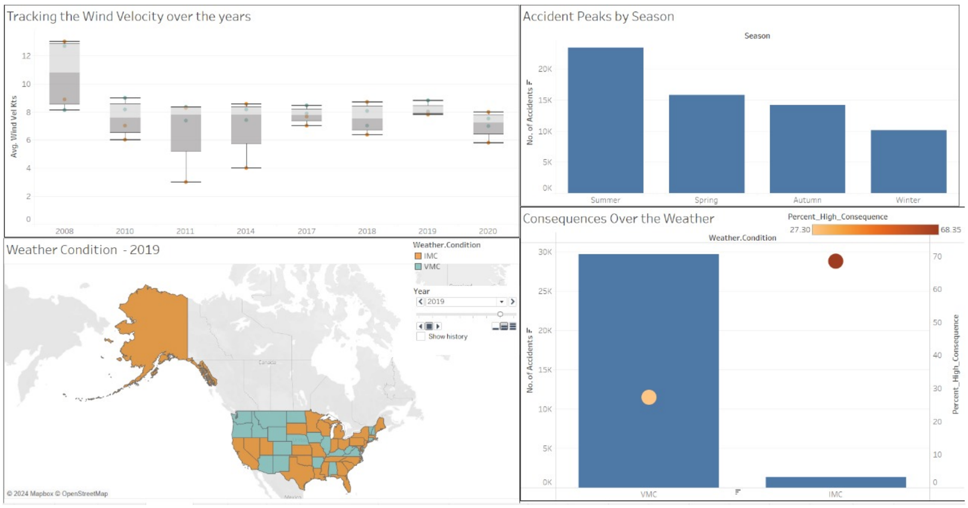

Figure 2: Dashboard Of Weather

5.2.1 Average Wind Velocity over the years(Box Plot)

Marks and Channels:

- **Marks**: Lines
- **Channels**:
  - **Y-Position**: Average wind velocity in Kts.
  - **X-Position** (Temporal): Year from 2008 to 2020.
  - **Color** (Categorical): Differentiates individual data points within each box plot according to weather condition.

Rationale:

- Illustrates wind velocity trends and variability over years.
- Identifies years with extreme wind conditions.

5.2.2 Accident Peaks by Season(Bar Graph)

Marks and Channels:

- **Marks**: Lines
- **Channels**:
  - **Y-Position** (Quantitative): Number of accidents.
  - **X-Position** (Categorical): Season (Summer, Spring, Autumn, Winter).

Rationale:

- Displays accident seasonality and peak periods.
- Useful for seasonal trend analysis.
- Easy for comparison across different seasons.

5.2.3 Mapping the Weather: Accident Conditions Across the States(Chloropeth Map)

- **Marks**: Area
- **Channels**:
  - **Color** (Categorical): IMC vs. VMC conditions.
  - **Position** (Spatial): Represents state locations on the map.

Rationale:

- Shows state-wise accident distribution under different weather conditions.
- Highlights regional accident risk levels.
- Maintains geographic context for spatial pattern recognition.
- Allows for quick identification of high-risk areas.

5.2.4 Consequences Over the Weather(Bar Chart with Overlay)

Marks and Channels:

- **Marks**: Lines and Points
- **Channels**:
  - **Y-position** : Number of accidents.
  - **X-position** : IMC vs. VMC.

  - **Color**: Indicates percentage scale.
  - **Secondary Axis**: Represents percentage.

Rationale:

- Dual-axis presentation shows both count and percentage.
- Clear comparison between IMC and VMC weather conditions.
- Color luminance adds an additional dimension of information.
- Effective for displaying multiple related metrics.

Insights:

- Higher wind velocities correlates with increased accident rates especially under IMC conditions as visibility and aircraft handling are compromised.
- By analyzing data across multiple years over regions, IMC conditions continously correlates with higher accident rates.
- Pilots operate aircraft in two types of weather conditions: Visual Meteorological Conditions (VMC) and Instrument Meteorological Conditions (IMC). In VMC, weather conditions are good enough that the pilot can navigate visually, whereas in IMC, the pilot is required to navigate the aircraft by instruments. Flying under IMC is generally considered a lot more challenging than VMC
- The total number of accidents for Summer is nearly twice the number of accidents recorded in Winter.

5.3 Time

5.3.1 Fatality Comparison Over the Years(Stacked Bar Chart)

Marks and Channels:

- **Marks**: Lines
- **Channels**:
  - **X-position**: Represents the number of accidents per year.
  - **Color**: Differentiates fatal vs non-fatal accidents.

Rationale:

- Displays trends in accident severity across years.
- Allows quick visual comparison of accident counts by severity.

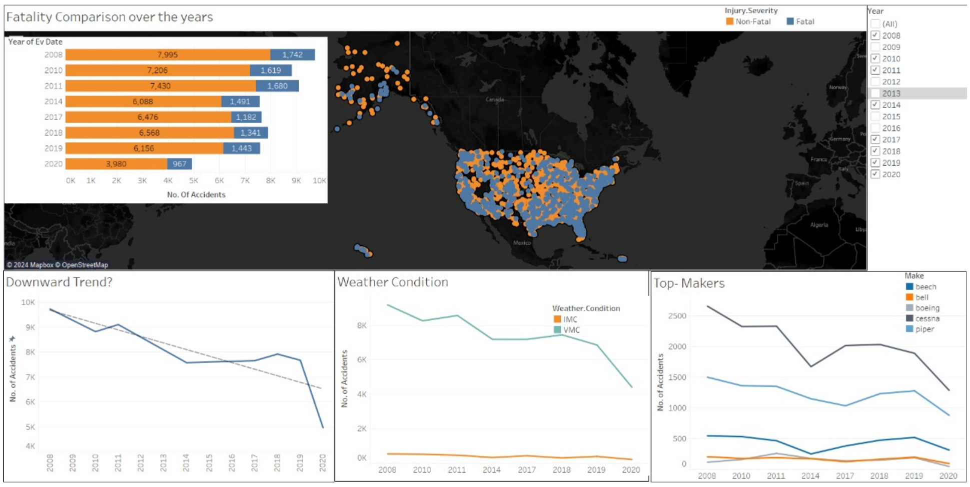

Figure 3: Dashboard Of Time

5.3.2 Geographical Accident Distribution(Point Map)

Marks and Channels:

- **Marks**: Points
- **Channels**:
  - **Position** (Spatial): Based on latitude and longitude.
  - **Color**: Distinguishes between fatal and non-fatal accidents.

Rationale:

- Visualizes the spatial distribution of accidents.
- Helps identify regional risk clusters.
- Color differentiation aids in assessing accident severity.

5.3.3 Downward Trend?(Line Chart)

Marks and Channels:

- **Marks**: Line
- **Channels**:
  - **Y-Position**: Number of accidents.
  - **X-Position** (Temporal): Years.

Rationale:

- Shows accident trend over time, highlighting decreases.
- Simple visual for observing year-on-year changes.

5.3.4 Weather Condition(Multi-line Chart)

Marks and Channels:

- **Marks**: Lines
- **Channels**:
  - **Y-Position**: Number of accidents.
  - **X-Position** (Temporal): Year.
  - **Color** (Categorical): Represents different weather conditions (IMC vs VMC).

Rationale:

- Illustrates the impact of weather conditions on accident rates.
- Easy to compare accident counts in different weather conditions.

5.3.5 Top-Makers(Multi-line Chart)

Marks and Channels:

- **Marks**: Lines
- **Channels**:
  - **Y-Position**: Number of accidents.
  - **X-Position** (Temporal): Year.
  - **Color**: Differentiates between aircraft makers (Beech, Bell, Boeing, Cessna, Piper).

Rationale:

- Compares accident counts across different aircraft makes.
- Reveals trends for individual manufacturers.

Insights:

- Aviation has advanced significantly since the 2008s with the addition of numerous innovations in safety engineering.
- Trend of maker graph raises a question that whether the higher accidents for a manufacturer is due to popularity or is there any serious potential issue?
- Weather condition shows that accidents in IMC have stayed constant and in VMC condition they have decreased.

5.4 Broad Phase Of Flight

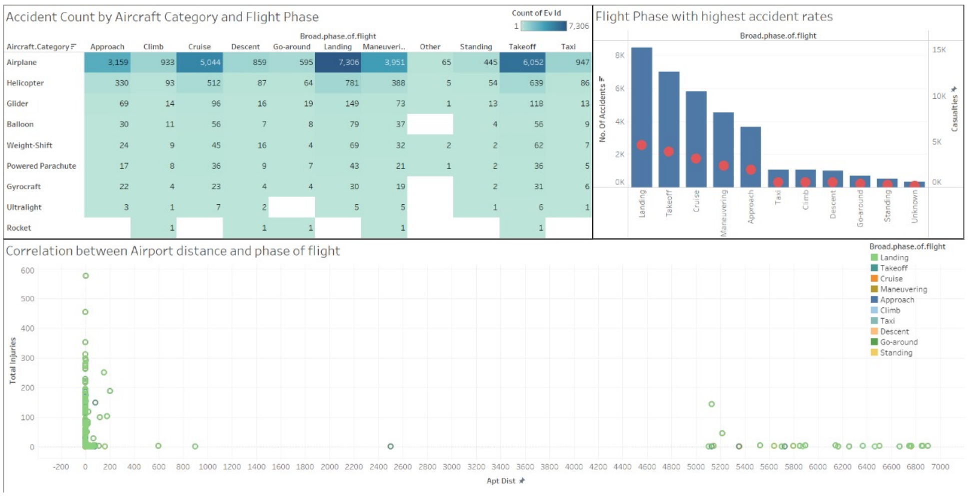

Figure 4: Dashboard of Broad Phase Of Flight

5.4.1 Accident Count by Aircraft Cateogry and Flight Phase(Heatmap Cells)

Marks and Channels:

- **Marks**: Point
- **Channels**:
  - **X-Position** (Categorical): Phase Of Flight
  - **Y-Position** (Categorical): Aircraft Category
  - **Color Gradient** (Quantitative): Count Of Accidents

Rationale:

- Highlights how different aircraft categories encounter accidents across various flight phases.
- Helps in quickly identifying where most incidents occur (e.g., landing and takeoff for airplanes).

5.4.2 Flight Phase with Highest Accident Rates(Bar Chart with Overlay)

Marks and Channels:

- **Marks**: Lines and Points

- **Channels**:
  - **Y-position** (Quantitative): Number of accidents.
  - **X-position** (Categorical): Phase of Flight.
  - **Secondary Axis**: Represents percentage

Rationale:

- Highlights which flight phases have the highest accident rates, with a secondary emphasis on the severity by overlaying casualty points.
- Helps in quickly identifying in which phase most incidents occur (e.g., landing and takeoff for airplanes).

5.4.3 Correlation Between airport distance and phase of flight(Scatter Plot)

Marks and Channels:

- **Marks**: Point
- **Channels**:
  - **Y-position** (Quantitative): Total Injuries
  - **X-position** (Quantitative): Airport Distance.
  - **Color**(Categorical):Broad Phase of flight

Rationale:

- Easier in examining if distance from the airport influences injury severity during accidents..

Insights:

- heavier aircraft like airplanes have a higher number of accidents during landing and takeoff phases.
- This visualization supports the hypothesis that landing and takeoff are critical phases of flight with higher accident rates, possibly due to the complex operations involved and the proximity to the ground.This is likely because the pilots mental processing capabilities are closer to their limit during the lading and takeoff phases.
- As airplanes and helicopter category of airplanes are widely used, mostly in all the phases of flights maximum accidents have occurred in this category.

5.5 Makers

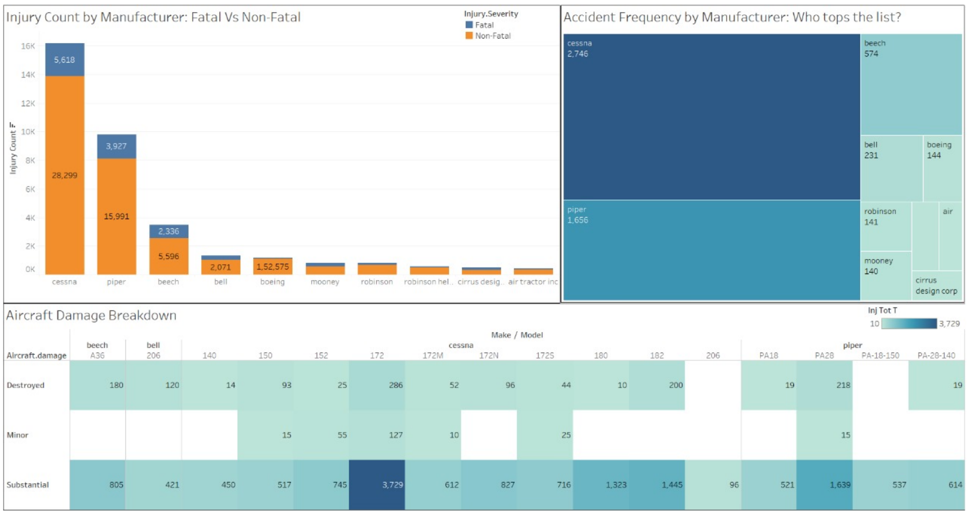

Figure 5: Test results for circuit 1

5.5.1 Injury Count by Aircraft Manufacturer:Fatal or Non-Fatal(Stacked Bars)

Marks and Channels:

- **Marks**:Lines
- **Channels**:
  - **X-Position** (Categorical): Manufacturer.
  - **Y-Position** (Quantitative): Injury count.
  - **Color** (Categorical): Fatal vs. Non-Fatal.

Rationale:

- Shows injury distribution by manufacturer.
- Compares fatal and non-fatal injuries within each manufacturer.
- Easy visualisation for composition

5.5.2 Accident Frequency by Manufacturer: Who tops the list?(Tree Map)

- **Marks**: Area
- **Channels**:
  - **Size** (Quantitative): Represents the number of accidents

  - **Color Gradient** :Distinguishes between manufacturers

Rationale:

- Visual ranking of manufacturers by accident frequency.
- Highlights major contributors to accident data.

5.5.3 Aircraft Damage Breakdown(Heatmap Cells)

- **Marks**: Point
- **Channels**:
  - **X-Position** (Categorical): Aircraft Make/Model.
  - **Y-Position** (Categorical): Damage type (Destroyed, Minor, Substantial).
  - **Color Gradient** (Quantitative): Injury count (darker for higher counts).

Rationale:

- Highlights damage distribution across models.
- Identifies high-damage models visually.

Insights:

- Cessna has most accidents in treemap so is that due to popularity or is there any potential issue in the manufacturer.
- Certain models show a higher tendency towards substantial damage indicating of design and operational vulnerabilities.
- On further investigation we found that Cessna is one of the most popular aircraft manufacturer in USA having highest market share indicating it's highest number of accidents.
- The 737 MAX, one of Boeing's most popular models, was grounded worldwide in 2019 after two tragic crashes linked to issues with the MCAS (Maneuvering Characteristics Augmentation System). Investigations revealed flaws in the design, inadequate pilot training, and an alleged lack of transparency in Boeing's development and approval process indicating significant number of accidents are not due to the popularity

5.6 Location

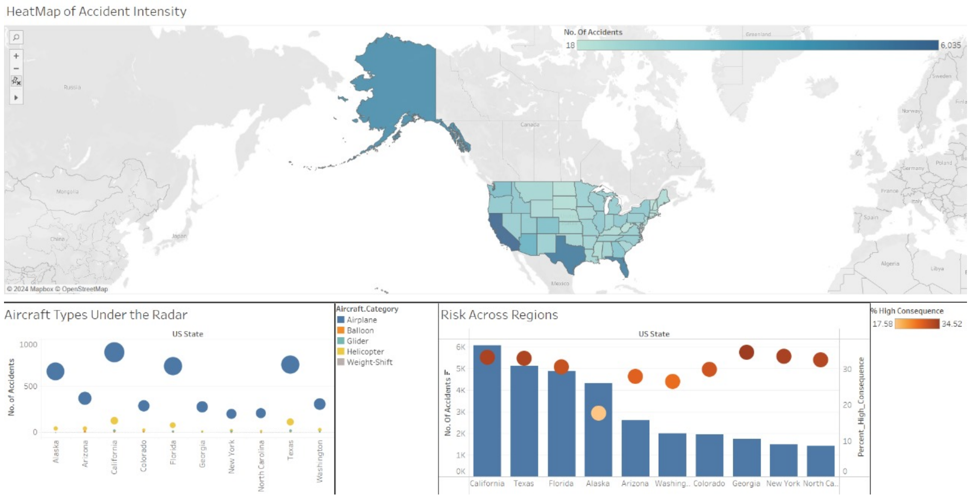

Figure 6: Test results for circuit 1

5.6.1 Heat Map of Accident Intensity(Choropleth Map)

Marks and Channels:

- **Marks**: Areas.
- **Channels**:
  - **Color Saturation**: Indicates the number of accidents by intensity.
  - **Position** (Spatial): Represents state locations on the map.

Rationale:

- Effectively shows geographic distribution of accidents.
- Color intensity provides immediate visual understanding of accident concentration.
- Maintains geographic context for spatial pattern recognition.
- Allows for quick identification of high-risk areas.

5.6.2 Aircraft Category Distribution(Bubble Chart)

Marks and Channels:

- **Marks**: Points
- **Channels**:
  - **Size**: Represents the number of accidents.

  - **Position** (Categorical): Categorized by US states.
  - **Color Hue** (Categorical): Differentiates by aircraft types.
  - **Y-axis** (Quantitative): Shows the distinct count of accidents.

Rationale:

- Circle size effectively represents quantity, allowing for visual comparison.
- Multiple categories can be displayed simultaneously.
- Allows for easy comparison of accident distribution across states.
- Shows both absolute numbers and relative proportions for aircraft types.

5.6.3 State-wise Accident Bar Chart(Bar Chart with Overlay)

Marks and Channels:

- **Marks**: Lines and Points
- **Channels**:
  - **Y-axis Position** (Quantitative): Corresponds to the number of accidents.
  - **X-axis Position** (Categorical): Organized by state.
  - **Color Gradient** (Categorical): Differentiates accident severity.
  - **Secondary Axis**: Represents percentage.

Rationale:

- Provides a clear comparison of total accidents across states.
- Shows severity composition of accidents.
- Allows for easy ranking and comparison of accident rates by state.
- Easy to interpret percentage distribution for high-consequence accidents.
- Effective for displaying a continuous data range of accident severity.

Insights:

- California has by far the highest accident rate with over 6000 accidents recorded. Following California is Texas, Alaska and Florida with nearly 4000 accidents each. Interestingly, Alaska has a relatively high number of accidents but a fairly low percentage of high consequence accidents. Conversely, there are other states, like New York, that have a low number of accidents and a high percentage of high consequence accidents.

- It is likely the number of accidents is somewhat correlated with each state's population. California might have the highest number of accidents but it also has the highest population. Texas and Florida also have high populations.
- Population doesn't however explain Alaska's high number of accidents, one of the least populated US states. Doing a little bit of research revealed that a large number of communities in Alaska are not connected to highways or road systems, making flying much more common among the general population. This coupled with Alaska's unpredictable weather conditions and mountainous terrain helps explain the high accident rate.

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6 Additional Important Graphs

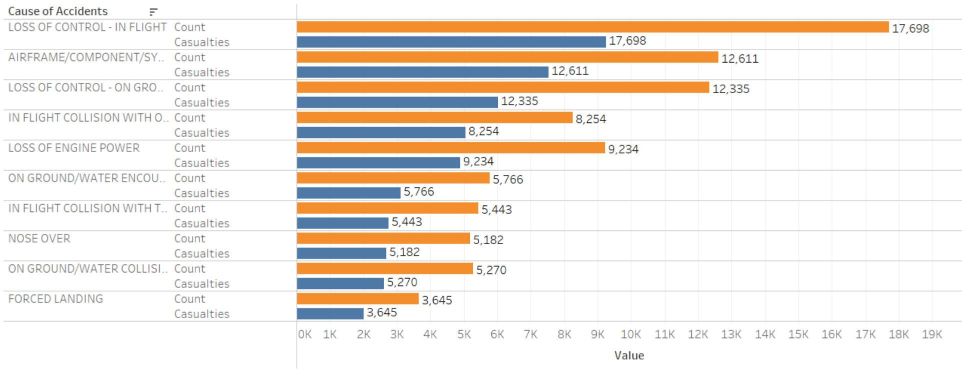

Figure 7: Causes of Accidents

- We can clearly see that loss of engine power is the leading primary cause of accidents in the dataset, followed by loss of control, in flight collision with object, and in flight encounter with weather.

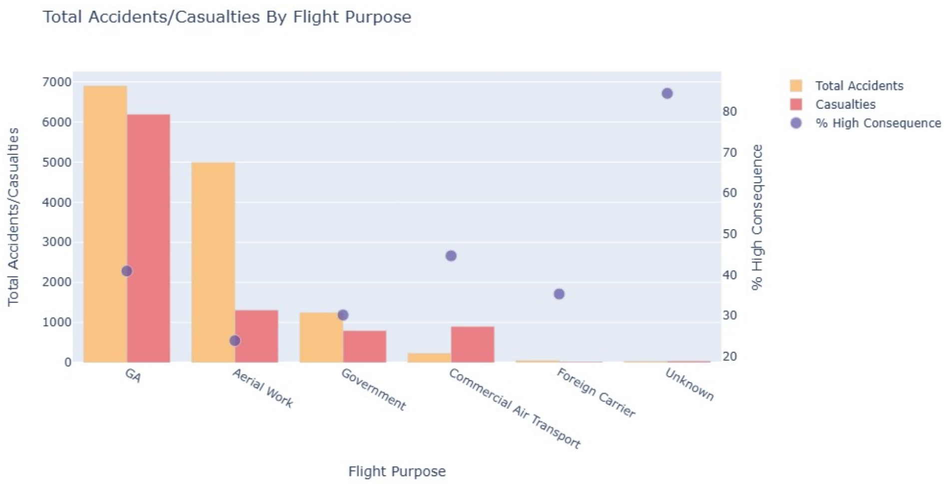

Figure 8: Another view of Purpose of Flight varying with number of accidents

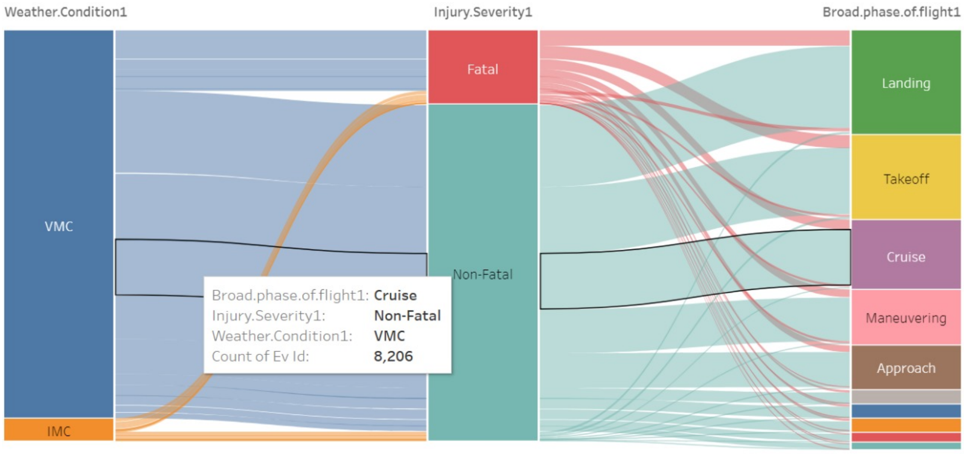

Figure 9: A quick glance of compilation of hypothesis made over Weather conditions and Phase Of Flight and how each affects the other in terms of injury severity

7 Key Takeaways

- **Increase Training for General Aviation (GA) Pilots in Adverse Conditions** - Since a large portion of accidents occur in GA under Visual Meteorological Conditions (VMC), encourage pilots to pursue additional training to handle Instrument Meteorological Conditions (IMC) through FAA-approved courses. Offering incentives for training in IMC proficiency could improve pilots' confidence and preparedness for unexpected weather changes.
- **Mandatory Pre-Flight Weather Assessments for GA Pilots** - Enforce stringent pre-flight weather checks for GA pilots, particularly during the summer months when accidents peak. Implementing automated reminders or weather assessment tools could help pilots make more informed go/no-go decisions based on weather.
- **Strengthen Safety Standards for Amateur-Built Aircraft** Given the higher accident rates and severity in amateur-built aircraft, introduce a stricter certification process that verifies structural integrity and safety features. Additionally, consider mandating that amateur-built aircraft pass periodic safety inspections by certified engineers.
- **Enhanced Safety Procedures for Takeoff and Landing Phases** - Since landing and takeoff are high-risk phases, particularly for GA, encourage pilots to undergo regular refresher training focused on best practices during these phases. Airports can also consider implementing additional visual aids or markers around runways to

aid in safer landings

- **Targeted Safety Campaigns for States with High Accident Rates** - Launch state-specific safety campaigns in states with higher accident frequencies, like California. Partner with local aviation organizations to hold safety workshops, promoting awareness about seasonal trends and accident prevention techniques.
- **Encourage Routine Maintenance on High-Risk Aircraft Models and Engines**- - Aircraft models such as the Cessna 172 and 182, along with reciprocating engine types, show higher accident rates. Emphasize frequent maintenance checks for these aircraft types and incentivize compliance through reduced insurance premiums or maintenance cost subsidies.
- **Promote Accident Awareness Campaigns for Weekend Flights**- - Given the spike in accidents over weekends, aviation authorities could organize awareness campaigns specifically targeted toward weekend flyers, emphasizing the importance of thorough pre-flight checks and risk mitigation practices.

By implementing these recommendations, aviation authorities and industry stakeholders can take proactive steps to reduce accident rates and enhance overall safety in aviation, especially for General Aviation and amateur-built aircraft.

One intriguing question that arises from our analysis is how an airline passenger can statistically assess their chances of surviving a flight. Interestingly, according to WikiHow, "The odds of dying on a commercial airline flight are as low as 1 in 9 million." While many things can go wrong at 33,000 feet (10,058 meters) above the ground, the choices you make in an emergency can significantly impact your outcome. In fact, nearly 95 % of airplane crashes have survivors, meaning that even in the rare event of a crash, your chances of survival are higher than most people might expect.